INTERNATIONAL

MARINE ENGINEERING

Published Monthly by ALDRICH PUBLISHING CO.

461 EIGHTH AVENUE, NEW YORK — 8 BOUVERIE ST., LONDON, E. C.

H. L. Aldrich, President and Treasurer — *Assoc. Member of Council, Soc. N. A. and M. E.*
George Slate, Vice-President
E. L. Sumner, Secretary
E. J. P. Benn, Director and Publisher — *Associate Inst. N. A.*

Edited by H. H. Brown, A. M. Inst. N. A.
Member Soc. N. A. and M. E.

Vol. XXIII — FEBRUARY, 1918 — No. 2

Shipbuilders Must Redouble Their Efforts

TO shipbuilders the entire nation will look during the coming months for unprecedented activity. Former records of production will no longer be acceptable. The seemingly impossible must be achieved, and that quickly. The diminished rate of shipping losses, encouraging as it is, in no way lessens the demand for more ships. Every ton of shipping that can be produced must be launched in the shortest possible time.

Less than a million tons of merchant shipping was produced in the United States last year, but, in the meantime, the foundations have been laid for a vastly increased output. No less than 700 shipways are now available, as against 148 last April, and more are rapidly nearing completion. According to official figures published in December the wooden ship programme is 9 percent complete; the requisitioned steel ship programme, 39 percent complete; the composite ship programme, 20 percent complete, and the contract steel ship programme, 4 percent complete. This much has been accomplished before the new shipyards have really begun to build ships and during a period when the older yards were largely engaged in naval work, and, furthermore, were seriously handicapped by labor and housing troubles.

Most of these preliminary difficulties are now being taken in hand, means are apparently in sight for relieving the most serious phases of the situation, and the new yards are squaring away for uninterrupted intensive production. It now remains for the shipbuilders to redouble their efforts and prove to the country that the responsibilities intrusted to them will be fully met.

Operation of the New Shipyards

TWO, at least, of the new Government fabricated steel shipbuilding plants will shortly be in operation. Successful shipyard operation, however, depends primarily upon the two factors of management and labor. In accordance with plans already perfected sufficient labor will in all probability be available for these yards, but it will consist mainly of men who have had little or no experience in shipbuilding and who must be trained. Under these conditions the real responsibility will lie in the hands of the executive organizations of the yards. Competent shipbuilders can be obtained only from other yards. More difficult still, however, is it to secure men with executive ability, combined with shipbuilding experience, who are accustomed to handling contracts running into the hundreds of millions to be executed within the short space of a few months. It is for this reason that we call attention to the suggestions made in an article published elsewhere in this issue in which a plan is outlined for utilizing as sub-contractors in the new yards the executive organizations and working forces available in kindred industries. This plan has the merit that such organizations have well defined working policies fully capable of producing results in steel construction work. The men are accustomed to working together and successfully carrying out large contracts in limited time. With proper supervision by expert shipbuilders such a method of co-ordinating working organizations as subcontractor units for the actual erection and completion of the ships at least is worthy of careful consideration, especially as it is a plan commonly used in large building enterprises, a conspicuous example of which is the construction of the Bristol shipyard itself.

Getting the Men to Build the Ships

WITH the combined aid of the Council of National Defense, the Shipping Board, Governors of States, and organized labor and business, the Department of Labor began on January 28 the recruiting of an army of 250,000 men to fill all present and future needs of the shipbuilding yards of the United States. Men skilled in any of the mechanical trades used in shipbuilding, and willing to accept employment in this branch of war industry, are being enrolled and registered in the United States Public Service Reserve, a division of the United States Employment Service. With the institution of this coast-to-coast drive for shipbuilders, the independent efforts of the Shipping Board, Council of National Defense and the individual shipyards cease, and the entire shipyard labor supply question is turned over to the United States Employment Service of the Department of Labor. Men fitted for shipbuilding work and shipyards in need of men will hereafter be brought together through the medium of the Federal Employment Service, which, with the co-operation of State and Municipal Employment Services, now has more than two hundred labor exchanges throughout the United States.

During a two-weeks' period, beginning January 28, thousands of "four-minute men" will explain to audiences all over the country what shipbuilding means to America in this war. They will tell of the requirements of the yards and encourage enrollment in the Public Service Reserve. Every part of the United States will be covered in this educational campaign, which will culminate on February 11 with a National Shipbuilders' Registration week, during which all the volunteers for shipbuilding will be registered as to their experiences, skill and trade by exports of the United States Employment Service.

Since the United States entered the war, millions of Americans have been waiting to be told what service they can best render. Trained riveters, boiler makers, machinists, blacksmiths, carpenters, calkers, millwrights and

other experienced mechanics can render no service more evidently needed than the service of the nation in the shipyards. Every skilled workman who volunteers for work in the shipyards may well feel that he has joined the military forces of America. Every rivet driven is a blow at the Kaiser; every ship turned out brings nearer the day of democracy's triumph. The Government counts confidently upon the patriotism of the skilled workmen themselves, but employers can be most helpful in facilitating the releasing from non-essential industries of the skilled workmen who desire to volunteer for the shipbuilding reserve.

Every man registered in the Public Service Reserve will not be immediately required, and the Department of Labor urges all workers to stick to their present posts until they are needed. It should be understood that there is no general labor shortage at the present time, but that the problem is purely one of distribution of labor where and when it is needed. Independent efforts in the past to obtain shipyard labor frequently resulted in premature and unnecessary removal of workers from the so-called non-essential industries and the unintentional taking away of men by one shipyard from another. Hereafter every shipyard in the United States in need of men will notify the United States Employment Service of its requirements and these will be filled without delay from the lists of unemployed and from the members of the Public Service Reserve. By knowing in full the number and ability of the men in the country fitted for and willing to work in shipyards as well as the immediate and future labor needs of the shipyards, the Employment Service will be able to meet every shipbuilding labor requirement as long as the war lasts.

Housing of Shipyard Workmen

ADEQUATE housing of shipyard workmen is absolutely essential before further expansion of shipbuilding facilities can take place. At practically every large shipbuilding center in the United States lack of housing facilities has been the principal cause of delay in the Government shipbuilding programme. More men are continually needed, but they cannot be obtained unless provision is made for their housing near the shipyards. This problem is further complicated by the fact that some of the larger shipbuilding centers have been chosen as the sites of military bases and army camps, thus further increasing the population in these communities and lessening the available housing facilities. Coupled with the housing problem there is also the question of transporting the workmen from their homes to the shipyards, in many cases the transportation facilities proving wholly inadequate. Committees from both the Shipping Board and the War Industries Board have thoroughly investigated these conditions and appropriations have been asked from Congress to carry out their recommendations. In no other way can the problem be solved and immediate action must be taken to relieve the situation.

New Set of Bunker Regulations

BECAUSE of the largely increasing number of vessels of all nationalities that have to get bunker licenses before they can clear from American ports, a new set of bunker regulations and rules has been announced by the War Trade Board, which becomes effective on February 1. No vessel is allowed to clear from any port of the United States or its possessions without having secured a license or licenses covering all bunker fuel, port, sea and ship's stores and supplies aboard the vessel at the time of sailing. The license or licenses must cover not only the fuel consumption and supplies taken aboard at the port of the United States, but also the fuel, stores and supplies which the vessel brought into the country when she entered.

The War Trade Board is desirous of doing everything possible to avoid the detention of vessels, but it is emphasized that voyages and charters for all neutral vessels, and all American vessels not requisitioned by the United States Shipping Board, should first be approved by the Charter Committee of the United States Shipping Board of New York. This committee will then inform the War Trade Board of the approvals they have given, so that the War Trade Board will have this information at hand when considering each application for license.

If these directions are carefully followed, delays will be avoided in granting licenses. The rules have been sent to vessel owners and other interested parties and may be secured upon application to the War Trade Board, Bureau of Transportation, Washington, D. C.

Important Step of North-East Coast Institution

THE important departure of the North-East Coast Institution of Engineers and Shipbuilders, in appointing a committee of expert engineers to test apparatus offered by manufacturers and accepted by the Council, has resulted in a very comprehensive report on the working of air pumps, such as are used in connection with the condenser plants of steam engines. The manufacturers in this case were Messrs. Richardsons, Westgarth & Company, Ltd., and the tests were carried out at their Hartlepool Works. The report, presenting as it does authoritative and reliable data, should prove of great value to engineers, especially with reference to the production of high vacuum for steam turbines and the more economical production of low vacuum for cargo vessels. Furthermore, it definitely marks the opening up by a scientific institution of a new and more valuable field of activity, and there can be little doubt that the example which the North-East Coast Institution has set will be followed elsewhere, so that ultimately organized scientific research in engineering and other branches of industry will become more active and general instead of passive and exceptional. When this much-to-be-desired ideal is reached, there will obviously be a speeding up in the recognition and adoption by manufacturers of improvements and an increasingly accelerated rate of progress in the industries concerned.

Life Saving Equipment for the Emergency Fleet

WHEN it comes to safeguarding or saving lives at sea, the best equipment is none too good. Actual life saving should be the prime consideration when it comes to the equipment of the vessels now building for the Emergency Fleet. Many of these vessels will be used as army transports and the cargo vessels will be manned not only by the ordinary crews for the navigation of the ships, but also by gun crews for the protection of the vessel. In any case, the men on board the vessels, subject to the danger of travel in the war zone, are the officers and seamen who have been trained to serve their country and the preservation and protection of their lives become of first importance. It should be remembered that the safety of all on board does not depend on the life-

boats alone, but also on the chocking and stowing of the lifeboats, on the reliability of the davits and releasing gears, and, in fact, on the merits and efficiency of even the smallest detail of the equipment. Even seconds count when it comes to releasing lifeboats and getting them overboard safely in time of danger.

Two years ago a new law was passed requiring all passenger ships under the American flag to be equipped with at least one power lifeboat. Under present conditions, the application of this rule to cargo ships would be a step in the right direction. One power lifeboat on each of the cargo ships now being built for the Emergency Fleet would provide safety for the entire ship and gun crews. A 28-foot motor boat, for example, with a capacity of forty to fifty persons, and, in emergencies, capable of taking care of double that number, provided with a reliable heavy duty engine and a fuel capacity of 150 gallons would have a cruising radius of about 300 miles at an approximate speed of 6 to 7 miles per hour. Such boats would be more expensive than the regular lifeboat equipment, but the increased cost, in our opinion, would be a negligible item as compared with the greater safety provided for the thousands of men who are volunteering for this hazardous service.

Combined Steel and Concrete Ship

THERE is now being developed under the name of the Hunnewell hull a new type of ship's hull, consisting of a steel or wood middle body and concrete ends, especially designed for the rapid and economical building of sea-going cargo vessels. This new style of hull, for which patents have been applied, is the invention of Constructor F. A. Hunnewell, U. S. Coast Guard, and is receiving attention from both naval constructors and private ship owners and designers.

Concrete as a material for shipbuilding is being widely exploited at the present time, chiefly in the form of complete reinforced concrete hulls for vessels. Progress in this direction, however, has been limited to vessels of small size and the optimistic claims of many of the reinforced concrete ship advocates remain to be substantiated in actual test. The proposal, therefore, to build vessels of steel or wood with concrete ends is an entirely new departure and one which takes full advantage of the two systems of construction.

The parallel middle body may be a simple fabricated steel structure designed to carry the loads of the machinery installation and the stresses on the hull in a seaway. The shaped ends, on the other hand, which are the more expensive parts of the steel hull to construct, are of reinforced concrete, so designed as to withstand under all conditions the water pressures and the local shocks and loads. This use of steel and concrete is justified, it is claimed, as a consistent and economical design, while the utilization simultaneously of the two distinct kinds of material and labor should result in more rapid construction than the conventional types of hull permit.

In such a design, it is obvious that from a constructional point of view the greatest possible length of parallel middle body will be advantageous. It is understood that experiments are being made in the model towing tank in Washington to determine the most satisfactory proportions of a parallel middle body in cargo ships at various speeds. Another interesting problem involved is the method of joining the reinforced concrete ends to the steel or wood hull. Several solutions to this problem are being investigated and no difficulty is anticipated working out this novel detail of ship construction.

LETTERS TO THE EDITOR

"The Return to the Reciprocating Engine"

You are right in your contention that a return to reciprocating machinery, particularly for auxiliaries in marine power plants, would be a step backwards. We send you herewith drawings and photographs which illustrate the saving in space and the gain in simplicity, and therefore reliability, obtainable with turbine-driven auxiliaries.

The reason that reciprocating engines have been used so extensively for the Emergency Fleet is that many shops are already equipped to build engines, while few concerns have the facilities and experience necessary for the production of the high-grade gears required for turbines for propulsion. The same consideration does not, however, apply to so great an extent in the case of auxiliaries.

Besides their simplicity, small size and less weight, turbine auxiliaries are more efficient. Although auxiliary exhaust can be applied to heating feed water, there is generally a surplus, which is either bled directly to the condenser, with an entire loss of its contained heat, or to the intermediate receiver and used with low efficiency in the low pressure cylinder. Is it not self-evident that the steam, which is expanded to about atmospheric pressure for feed heating, should in the expanding process contribute as much power as possible; that is, that the auxiliaries should have the highest attainable efficiency?

Turbine-driven units maintain their initial efficiency almost indefinitely, since they are not affected by leakage of valves or piston rings, and any wear of turbine buckets which may come about after long use is quickly and inexpensively remedied by the insertion of new buckets. The same applies to pump parts.

Turbine-driven auxiliaries are most flexible as regards conditions of operation. They will operate on steam at any practicable superheat or at any pressure without injury. Likewise, turbine-driven centrifugal units are self-regulating, no harm or trouble being experienced if the discharge is suddenly cut off or opened wide, and the piping system is free from vibrations, pulsations or water hammer.

The elimination of sliding surfaces and of numerous valves and packings diminishes the attention and labor required. Also, the fact that in modern turbine manufacture all parts are made interchangeable on a limit-gage basis renders the insertion of renewals or repairs a simple matter, which is further facilitated by their light weight and small size.

About the only supply required for turbine-driven auxiliaries is bearing oil, in amount about equivalent to that used by an electric motor. No oil or grease is introduced into the auxiliary exhaust, simplifying the task of keeping oil out of the boilers.

As to the matter of reliability, Mr. Heward, who writes in your December issue, should turn to page 545 of the same number and read the paragraphs by Captain Dyson beginning "One of the great sources of failure to hold high speed in vessels had been the continually recurring breakdowns of forced-draft blowers with engines of the reciprocating type," and, after describing one make of turbine blower unit tried, concluding, "This error was corrected and the fans, by their later performances, instilled such confidence that no other type of blower than that of the turbine-driven has since been considered for destroyer work, and in later vessels of other types it has even

shouldered the electric-driven fan out of the way, as the flexibility of control is so much greater."

Referring to the illustrations, Fig. 1 shows a 10-kilowatt, direct-current generating set as used for auxiliary lighting purposes. A velocity-stage turbine drives a directly connected generator at 3,600 revolutions per minute.

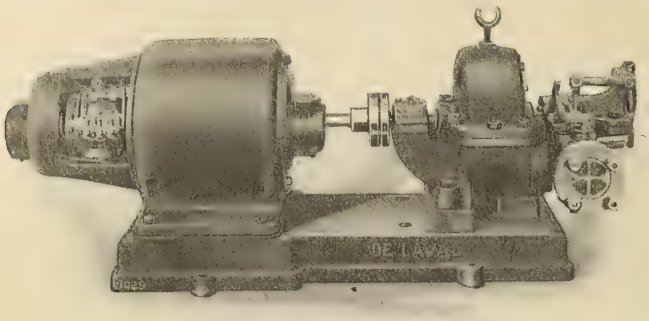


Fig. 1.—Small Auxiliary Lighting Set. Consisting of Direct-Current Generator Driven by Velocity-Stage Turbine; 10 Kilowatts, 3,600 Revolutions per Minute.

Fig. 2 shows a turbine-driven geared circulating unit having a capacity of 5,500 gallons of water per minute against a total head of 27 feet. The turbine is of the simplest type, having two rows of impulse buckets mounted on a single wheel or disk. The speed-reducing gear makes possible the use of a high-speed turbine and a slow-speed, large-diameter pump, as required for efficiency for large capacities and low heads. All working parts—that is, the turbine wheel, the gears and the centrifugal pump impeller—are at once accessible upon lifting the casing covers and without disturbing piping or bearings. The total space occupied is only 95 cubic feet, and the weight approximately 4,800 pounds.

Fig. 3 shows a combined turbine-driven boiler feed pump for 3,000 boiler horsepower capacity, the whole occupying a space of only 23 cubic feet and weighing 1,200 pounds. In this unit the turbine rotor and pump impeller are mounted upon one shaft and contained in one casing. The suction end of the pump is adjacent the turbine exhaust, metallic packing being used. As the pressures are very low, any leakage of water or steam is immaterial. The packing at the discharge end of the pump also is subjected to suction pressure only, due to the use of a hydraulic balancing system, while the packing at the inlet end of the turbine is subjected to exhaust pressure, the turbine being of the impulse type with a single pressure stage. There are only two bearings and one valve, viz., pressure governor valve. Comparison is invited between the space occupied by this unit and that required for reciprocating boiler feeders.

Trenton, N. J. GEO. B. GIBSON,
The De Laval Steam Turbine Company.

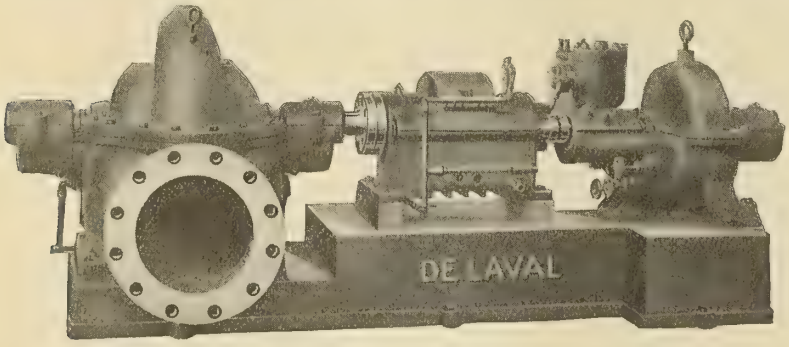


Fig. 2.—De Laval Geared Turbine-Driven Centrifugal Condenser Circulating Pump

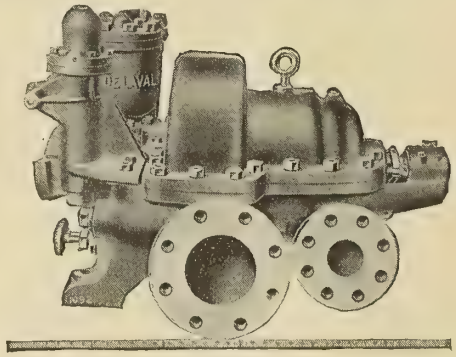


Fig. 3.—De Laval Turbine-Driven Boiler Feed Pump; Capacity, 3,000 Horsepower

S. S. Freeman

THE thirteenth vessel launched by the New York Shipbuilding Corporation, Camden, N. J., in 1917 was the S. S. *Freeman,* a single-screw steel collier, with machinery located aft, originally contracted for by the Pocahontas Transportation Company. The keel was laid in June and the vessel was about 85 percent complete at the time of launching on December 27.

The *Freeman* is 332 feet 6 inches long over all; 319 feet long on the waterline, with a molded beam of 49 feet 3 inches and a molded depth of 27 feet 6 inches. She has a single deck with poop, bridge and forecastle. A double bottom extends all fore and aft, and peak tanks are provided for water ballast. There are steel deckhouses on the poop and bridge and a wooden pilot house on the bridge deck house. The crew is berthed aft alongside the engine casing on the main deck.

The cargo space is divided into four holds. Steel cargo hatches are built to form a continuous girder along each side. The forward end of the poop is arranged for a coal bunker with hatches on the poop deck with coal trunks leading to the forward end of the boiler room. A plate bulwark is fitted between the poop and bridge and between the bridge and forecastle. The capacity of the four cargo holds, including the trunks, measured to the top of the tank, is 230,000 cubic feet.

Two tanks for drinking water, of 2,700 gallons' capacity each, are located in the after engine room. The reserve feed tanks are in the double bottom under the boiler room.

The vessel will carry 4,900 tons total deadweight on a draft of 20 feet 8 inches, or 5,450 tons on a draft of 22 feet 8 inches. She is designed for a sea speed of 10½ knots under ordinary conditions.

There are eight main hatch openings, each 15 feet by 28 feet, with patent steel hatch covers. For raising the hatch covers, there are eight built-up plate and channel king-posts securely bracketed to the trunk top and fitted with arrangements for securing the covers when open. Two pole masts are fitted, stepping on the trunk and equipped with crows' nests. A spruce boom, 12 inches by 40 feet, is fitted on the foremast capable of lifting a 2½-ton working load.

The propelling machinery consists of a vertical, direct-acting, triple-expansion, surface-condensing engine with cylinders 21 inches, 35 inches and 58 inches diameter by 42 inches stroke, supplied with steam at 200 pounds per square inch working pressure by two single-ended Scotch boilers, 14 feet 3 inches inside diameter and 11 feet 5/16-inch length between heads arranged to fire fore and aft with the fire room forward. The main condenser is cylindrical in shape and contains about 2,720 square feet of tube cooling surface. The shell is built of steel plate and the heads of cast iron.

Who Will Build the Fabricated Ships?

Organized Working Forces from Kindred Industrial Plants Suggested Remedy for Shortage of Skilled Shipbuilders

BY ROBERT E. KLINE *

ABOUT six months ago American shipbuilders were called in conference at Washington by the Shipping Board to devise means whereby during the succeeding year the output of ship tonnage then under contract could be at least doubled. Such a task, said the shipbuilders, is a physical impossibility. As their reasons, they cited the lack of sufficient shipyard labor and the lack of facilities in the country for turning out the additional raw and manufactured materials requisite for the work.

In view of the dire necessity for more ships, however, the Shipping Board Emergency Fleet Corporation "took the bit in their teeth" and, although against the judgment of experienced shipbuilders, launched a programme entirely new in the annals of the shipbuilding industry. That the Shipping Board did launch this unprecedented programme, against the counsels and advice of those most skilled in the shipbuilding industry, shows their indomitable purpose to succeed and to secure results when necessity demands. There was no time for temporizing, nor was there any intention of crippling existing shipbuilding industries by encroachment or competition or working to their detriment. On the contrary, it was the purpose of the Shipping Board to afford at the same time to the existing agencies in ship production all necessary co-operation and support; in fact, more than heretofore. It was just as essential to secure as large an increase in the output of these concerns at the same time as the additional output from the proposed new yards.

New Government Shipyards Projected

It was the plan of the Shipping Board to harness up, as new factors in the production of shipping, certain industries kindred to shipbuilding and artisans skilled in similar work. Three new shipyards were to be established, one at Philadelphia, one at Newark and one at Bristol, in which standardized vessels were to be built from parts fabricated in the structural shops throughout the country. The act of creating new assembling yards for the standardized building of fabricated ships is now being paralleled in practically all the lines of war industry, and is, therefore, presumably a logical expedient to the end. From my personal experience thus far as U. S. plant engineer in charge of the work at the Bristol government yard from its inception, I am fully convinced by reason of the results already attained that the programme can be carried out, and that, too, practically within the time set down, both as regards the construction of the new plants as well as in the construction of the ships.

Government Plans Arouse Criticism

There has been much criticism, some of it more or less just, that the measures adopted in plant construction thus far have been extravagant. As measured against the imperative necessity of building these yards, and thereafter the quota of ships, within the stipulated time, there is no time to haggle over these necessary expenditures if the funds are honestly applied. In view of the great crisis which the nation is facing, the amounts expended for this work become insignificant; besides, the money is being spent at home.

The contention is made, however, and justly, that the old shipyards, endeavoring in the same spirit to meet the war emergency needs, are tied to unprofitable contracts and are thereby unable to compete with the Government now launching this new enterprise. This phase of the subject is worthy of attention, but the Shipping Board is endeavoring to meet this situation by certain allowances. In any case where the necessary adjustments have not been made, upon proper determination of this fact such matters will undoubtedly be adjusted upon a basis entirely satisfactory to all, so that such ship production will not be impeded, but, on the contrary, will be accelerated.

Men Drawn From Established Yards

The main cause of this outcry from the old shipyards, however, is the fact that much of the labor, both skilled and unskilled, hitherto employed in the older yards is being attracted to the new yards by increased wages and other inducements. It is to offer a solution, if possible, of this phase of the matter that this article is written.

At this particular time, when the three great Government shipyards are about ready to assemble their forces for ship construction, the question of who will build these fabricated ships is of paramount importance. It is obvious that in any plan involving the establishment of new shipyards, help must not be drained from the old shipyards, nor must the personal interests of the older shipbuilders be violated. How, then, shall the problem be solved?

A Way Out of the Difficulty

In my opinion, the most logical and practical plan is for the three shipbuilding corporations (acting as agents for the Emergency Fleet Corporation in operating the new Government plants) to secure as sub-contractors for the actual erection and completion of the ships in the yards working organizations, including the executive working staffs from the industrial plants of the country that are best fitted by previous experience in similar work for carrying out the various processes in shipbuilding. There are hundreds of industries in our country, particularly in the Middle West, which are now idle, due to lack of working materials because of war demands. Under normal conditions in the past these industries have been engaged in work kindred to that of shipbuilding, and they can not only provide complete overhead organizations with defined and successful working policies, but they can also furnish the complement of labor forces for these new yards without encroachment on the old yards, if they are called into this service. Furthermore, their adoption will no doubt suggest the means to provide additional and necessary help where the need of same is felt in yards now operating.

In making this suggestion, I lay no claim to its originality, as it may already have been discussed and determined upon or rejected in councils higher up. In fact, it is but a suggestion to use the plan usually pursued in large

* Plant Engineer, United States Shipping Board Emergency Fleet Corporation, Bristol, Pa.

building enterprises—that of co-ordinating forces from various crafts on one contract, yet under distinct organizations. It is the plan which has so successfully been followed in the building of the Bristol Government shipyard. Here in a short period of four months the plans for the yard have all been evolved, and the plant, providing a shipyard and shops adequate for the assigned task of building sixty 9,000-ton ships within a period of eighteen months from this date, has practically been completed. Considering the time involved and the enormity of the task, its completion in so short a time is a remarkable achievement.

This success, however, is attributable not only to the excellent capability, foresight and determination on the part of the management of the Merchant Shipbuilding Corporation, agents for the Government on this contract, but by reason of the fact that they collected together working organizations as sub-contractor units to carry out such portions of the construction as they were particularly fitted by their experience to undertake. In other words, it is the same plan that I am suggesting as a possible solution of the problem as to who will build the fabricated ships.

How the Plan Worked in Building the Bristol Plant

Taking the case of the construction of the Bristol yard by the Merchant Shipbuilding Corporation as an example, the various contractors engaged in this gigantic task, and who, by their co-operation under the leadership of the main organization of the company, have brought the work to a successful conclusion, included the following: For building shipways, craneways' foundations, including outboard piling, John Monks & Sons, New York; housing and ship buildings, Fred T. Ley, Inc., Springfield, Mass.: installation of power plant equipment, machinery, pipe lines, electrical and mechanical equipment, William Gordon Corporation, Philadelphia and New York; concrete piling, Raymond Concrete Pile Company; furnishing and erection of structural steel on buildings, Leverring & Garrigues; dredging, American Dredging Company, Philadelphia; construction of pier and bulkhead, George E. Cantrell, Inc.; power house stacks and other labor work, Alphons Custodis Company.

Such elements of construction as were not disposed of by sub-contractors were handled by the organization of the Merchant Shipbuilding Corporation, headed by W. H. Mason, superintendent of construction. Mr. Mason was the master head of the composite unit, embracing the several sub-contract forces referred to as well. In this case, therefore, co-operation between various sub-contractors as led by the main organization of the company and by those in charge for the Government was the keynote of success. The fact that this method can be applied so successfully in plant construction leads to the presumption that a similar process of procedure will likewise be successful if applied to ship construction.

Organized Industries and Men are Available

Many concerns with their entire complement of organizations, in the Middle West particularly, are now idle through inability to secure raw materials. It is, therefore, urged to make use of such organizations, particularly as it is important to have not only sufficient skilled and common labor for ship work, but also to have perfect working executive organizations for carrying out the work. This, in my belief, can best be obtained by resorting to sub-contract methods. Without such experienced organizations in charge of the work, the mere herding of labor on these shipbuilding contracts, even if available in greater numbers than needed, and even though many of them have attended the shipbuilding training schools now in vogue, would result in muddle and great financial loss in actual ship construction, besides the loss of valuable time.

The pessimist who has criticised this new plan of shipbuilding has said that there would probably be no doubt of successful attainment in the construction of plants and yards, because this is in the usual line of construction, but that the same success could not be expected when ship construction is involved.

The practical shipbuilders, including many of our own government ship experts now retained, decry my suggestion as being impracticable. They say that men heretofore engaged in allied crafts make poor shipbuilders, that this has been proved by precedent and where tried in a few instances in the past had to be given up.

Perhaps so, but, in this new case, where new men must be had and the assembling of standard parts will constitute the routine of shipbuilding, this objectionable phase in work of allied crafts, if existent at first, will be quickly eliminated and their early inaptitude under the watchful eye of these few ship experts now retained will result in but little damage and delay, if any at all, and this will pertain only to the first short interval of work. They will soon be proficient.

Conclusions

In conclusion, I see no reason why such allied factors, collectively efficient as cited, should not be contracted with or otherwise obtained as working units to perform their respective portions of this enormous task and to assure the scheduled completion thereof without interference with other shipyards. Whatever is done, however, must be done *at once*. Men interested in shipbuilding heretofore should combine their best efforts in aiding the Shipping Board in carrying out its shipbuilding programme. The new shipyards are in business to stay and to help win the war, and must be fostered to that end, not opposed. Who better than these experienced heads are able to perform this great service?

Differences have existed at times in the Shipping Board as to methods, but none as to the objects to be attained. All are equally imbued with the same patriotic loyalty to our nation's welfare and with the same desire to make available quickly the much-needed tonnage.

The available ship experts must be driven to "pep" new to their experience by master administrators, as upon the latter will fall the new real responsibility for getting out the necessarily speeded output of ships, all of which must be completed with intensive expedition to supply the demand as well as to restore normal economic conditions generally.

Annual Motor Boat Show

"What the motor boat industry is doing to help win the war" was the keynote of the fourteenth annual National Motor Boat Show, held in the Grand Central Palace, New York City, January 19 to January 26. Although many exhibitions are being omitted this year on account of war time conditions, the fact that practically the entire motor boat industry is engaged in manufacturing hulls, motors and equipment of various sorts for the government, to say nothing of submarine chasers and other naval vessels, has been a sufficient reason for the leading concerns in this important industry to make extensive display of their products at this show. The display was not only educational, but patriotic and inspiring as well.

Co-ordinated Transportation Between Railways, Ocean and Rivers*

Comprehensive Plan for Developing the Inland Waterways of the United States—Waterways Commission Proposed

BY HON. FRANCIS G. NEWLANDS†

IN order to have a thorough-going system of transportation, both for the prosecution of the war and for the commercial contest which is to follow the war, we need a system of co-ordinated transportation between the railways, the ocean and the rivers of the country.

Neglected Merchant Marine

For years we have neglected our merchant marine. We have done so because of radical differences of view between the two great parties of the country as to the policy which should be pursued. The war came and forced upon us an immediate solution of this question.

The only adequate solution, which was entered upon reluctantly by many, was to cut the Gordian knot and turn over to the Government itself the task of creating and owning a large merchant marine. That work is now progressing, and we will find a merchant marine created not only to meet the requirements of the war, but the commerce of the country after the war. The only unattended-to link in transportation thus far has been that of river transportation.

We have in this country the greatest rivers in the world. In no country on earth would it be possible to create such a splendid system of waterway transportation as we might have in the United States. Yet we have addressed ourselves to this question in the most superficial manner. We have allowed the "spoils system" to prevail, the system of individual initiative by a Congressman or a Senator in a particular district or a particular State, in the shape of a bill urging a local development. We have never had a comprehensive study of all our rivers from source to mouth, with all their tributaries, a careful survey of the engineering possibilities, a careful estimate of the cost. We have never yet proceeded under broad and comprehensive plans to enter upon the great constructive work of river development, the work of making our rivers as effective instruments of transportation as the rails, with not only a track, in the shape of a perfect channel, but with a bank protection so created as to avoid destructive overflows; with transfer facilities and terminal facilities enabling them not only to compete with the railways, but to co-ordinate with the railways wherever necessary.

Half a Billion Spent Under Spoils System

And we have spent five hundred or six hundred millions of dollars under the system of individual initiative, popularly known as the "spoils system," without appreciable headway in the development of river transportation.

Compare the economic development of Germany, France and Austria, and even Russia, with this, and you will find in each of the first three countries named there is a perfect system of co-ordinated transportation between the rivers themselves by connecting them at their sources, wherever necessary, with artificial channels. Thus you have not only perfected channels, perfected banks, perfected transfer facilities, perfected terminals, but also rivers so connected with each other by artificial channels that you can go from any part in France or Germany to any other part as well by river as you can by rail. The two systems are so co-ordinated with each other and with the ocean system, under governmental authority, as to produce a perfected system of rail, river and ocean transportation.

To-day, in the very throes of war, Austria and Germany are building a channel between the head waters of the Rhine and the head waters of the Danube, with a view of developing the commercial facilities of those countries after the war. This will result in an enterprise which will give one system of inland waterway all the way from the North Sea down to the Black Sea, into which the Danube enters. Then these two great rivers—the Rhine and the Danube—will be connected with almost all of the other rivers of these two countries in such a way as to make as complete a system of waterway transportation as they have of railway transportation.

Causes for Neglect

When we think how we have neglected our rivers, we inquire as to the cause. One cause has been the desire of the individual Congressman or Senator to maintain his power regarding appropriations, be able to go back to his district or State and hold up as the evidence of his usefulness a bill on an appropriation calling for the development of a project within his district. Another reason has been that the railroads themselves, in this great period of war expansion, building their railroads out as pioneers into communities where there was little or no population, and dependent for future prosperity upon building up a transportation business, have regarded with great jealousy any existing system of river transportation that competed with them.

So we had there quite persistent interest raising false issues as to economy here, raising conditions of confusion there, and through many disturbing influences, preventing us from entering upon any conceived scheme of river legislation. The result has been that the very imperfect system of river transportation that once prevailed has been destroyed because we have permitted the rail carriers to club the river carriers out of existence. We have enabled them to sandbag their competitors, or have permitted them to do so.

Comprehensive Waterway System to Benefit All

However, I am glad to say that after ten years or more of constant agitation with reference to a bill which I had the honor to introduce, and which is well known by the chambers of commerce and waterway associations of the entire country, the provisions of that bill, in a modified form, with the aid of this Administration, were inserted in the last Rivers and Harbors Bill. We have there complete authority to the President to organize a waterways commission, which will bring into co-ordination the ten or twelve engineering services of the country now engaged in

---

* From an address before the Editorial Conference of Business Papers, Washington, D. C., December 13, 1917.

† Senator from Nevada and chairman Joint Congressional Committee on Interstate Commerce.

a detached way, not in a co-ordinating or co-operative way, upon some problem of the water question, to bring them into co-ordination through a commission. Also authorizing this commission to secure the co-operation of the States with the Nation in great works involving the jurisdiction of all the sovereignties, so that the Nation and the States, by a system of team-work, can proceed with the great work of developing these rivers not only for navigation, but for the use of the flood waters in irrigation; also for use in the creation of water power, for their control in the development of swamp lands and their reclamation, and for other forms of waterway development which will turn these great destructive waters, which have every year or so fixed upon the country a loss of $200,000,000, from destroyers of wealth into creators of wealth.

Difficulty of Convincing Congress

It is true that it has been very difficult to impress Congress with the importance of this measure. But the action has not been adequate; we have simply the form of the organization with an appropriation of a hundred thousand dollars for organization and plans. The bill which I originally introduced provided for an appropriation of sixty million dollars for ten years, six hundred million in all.

Congress and the country stood aghast at the prospect of spending six hundred million dollars upon the development of our rivers. Now we have become so accustomed to big sums that I imagine there will not be the same apprehension regarding the huge figures. If we can afford to spend between sixteen and twenty billion dollars for our railways; if we can contemplate an expenditure by the railroads themselves of a billion dollars every year for additional equipment and facilities (and that is stated by the railway authorities as the amount that is necessary), we can certainly look with complacency upon the expenditure of sixty million dollars annually upon our rivers.

And if that amount is spent—though I favor even more—for ten years, under a comprehensive plan, with consecutive work and without political interference, the country will be amazed at the results. The rivers can carry the bulky traffic which now congests our rivers, that kind of traffic which is large in bulk and low in rate, the neglect of which, by giving preference to other traffic paying higher rates to the railroads, produced this condition of scarcity in the coal supply. It almost, at one time, paralyzed the industries of the country.

I think that the development of our rivers and, of course, the connection of them with canals, would have absolutely prevented this great congestion.

Just to give an illustration, when I was a member of the Inland Waterway Commission, appointed by Mr. Roosevelt, we sailed down the Mississippi River, and it was distressing to see how little that river was used. Only semi-occasionally would we come across any signs of navigation. One day I remember seeing fifty barges, each containing about a thousand tons of coal, going down the Mississippi River, having come originally from the Ohio, steered by a small tugboat. They were going down with the current, practically, without much use of motive power, the tugboat simply steering this immense raft of barges which preceded it.

Think how small the expense of that tugboat was; how few men were employed upon it, yet they were guiding fifty thousand tons of coal. A large car will carry fifty tons of coal; a train of twenty loaded cars is a fairly good train. That would mean twenty times fifty—one thousand tons. A train, therefore, would carry a thousand tons; this little tugboat on the Mississippi River guided fifty thousand tons.

This is a fair illustration of how the rivers can be used for distributing cheap products.

Chesapeake and Erie Canals

The Chesapeake & Ohio Canal has been for years and is being used for transportation of coal. That canal, I understand, is under the control of the Baltimore & Ohio Railroad and is a part of its system, but it is used largely in the transportation of coal.

Then there is the Erie Canal. I don't know whether that is used extensively in the transportation of coal or not, but, of course, you all know that it has been a tremendous factor in keeping down the rates, and it has also been a great factor in actual carriage of bulky products.

There are few other canals in the country of any great length. That is the difficulty. It is of little advantage to have merely a stretch of a hundred or two hundred miles on a river perfected for navigation, nor is it of much advantage to have a tax canal here and there; the rivers and canals must all be connected so as to form a continuous network of waterway, just as we have a continuous network of rails throughout the entire country. Of course, the mileage would not be as great as that of rails. The usefulness of these small canals built in ancient times, when water was about the only means of transportation, furnishes no argument against the large and comprehensive scheme I have presented.

Proposed Canals of National Importance

I have no doubt it would be very important to have a connected system of inland water route transportation all the way south from Boston to Florida. That can easily be done. They have connected, they have dug a canal through Cape Cod which shortens the distance from Boston to New York by many miles and avoids the fogs of Nantucket. Of course, Long Island Sound is a protected waterway, used so largely by vessels going through this canal.

Then we come to the Raritan River, flowing through New Jersey, serviceable for a connection with Delaware Bay, connecting with some other river, and finally with the Delaware River, which the Raritan Canal is designed to complete. There is also a canal to connect the Delaware backward with Chesapeake Bay; also another canal connecting with Pamlico Sound in North Carolina, etc.

Throughout that entire distance there can be a system of waterway transportation that would be protected from the storms of the ocean. We can go further and run a canal across Florida. I have been told it is considered entirely practicable on the Gulf of Mexico, on its northern shores, to have an inland waterway, connected system of bays and sounds, to be traversed by small boats.

Connecting Links of Prime Economic and Strategic Value

These canals will be used mainly for connecting either existing sounds and bays and gulfs, or linking great river systems. The Mississippi River connects with the Missouri River, and I presume that from New Orleans to the source of the Missouri River is a distance of three or four thousand miles. The Missouri River rises in Montana, but the source of the Snake River, on the Pacific Coast, is also in Montana. All that would be necessary would be to connect the head waters of each of these rivers by a canal such as Germany and Austria are now engaged in digging between the head waters of the Rhine and the head waters of the Danube. This would connect New Orleans practically by waterway with Portland, Oregon,

on the Columbia River, the Snake River being a branch of the Columbia.

Consider that one river and its development. The Columbia River is a very noted river emptying into the ocean near Portland, Oregon; Portland has been growing as a great commercial city. The Columbia River has a tremendous grade in some places, causing large falls. They devised a system there of getting around those falls by locks. Economically that great fall of water is of considerable value for the development of water power.

Improvement by Army Engineers

The Columbia River has been taken care of in a rather disjointed way through the Engineering Corps of the army, which is in charge of so-called river and harbor work. The upper part of the Columbia and the Snake, its tributary (the two belong together, traversing the States of Oregon, Washington and Idaho), is under the jurisdiction of the Reclamation Service, in the Interior Department, the Engineering Corps of the army being under the War Department.

The Reclamation Service of the Interior Department is seeking to solve the problem of distributing those waters which have their sources in the snows on the mountains over the arid plains for purposes of irrigation. Incidentally in connection with the construction of their dams for irrigation, they are developing water power to a very great extent.

Two Engineering Staffs Which Should Co-ordinate

Under our present system the two services (Engineering Corps of the Army and the Reclamation Service of the Interior Department) are proceeding absolutely without co-ordination or co-operation of any kind. That entire system of rivers—the Columbia and the Snake, with all their tributaries—should be treated under well-considered, comprehensive plans, whereby these two engineering services would share the making, and in the execution of which each service would do under primary plans the work coming within its jurisdiction.

That is a system of co-ordination which Brazil has sought to bring about, which has never been brought about by administration, and could not under existing law be accomplished through mere administration.

Coast and Geodetic Survey

In addition to those two services, there is the Coast and Geodetic Survey that is at work on problems relating to the Columbia River—that is, jurisdiction over the rivers. The Geological Survey is also making studies upon the question of waters, their sources, utilization and development. Yet each of these capable scientific services is conducting its work without any co-operation or co-ordination with the other. It is the purpose of this movement to bring about absolute co-operation not only between these scientific services of the nation, but also to bring about their co-operation with similar agencies in the State.

In Oregon they have a waterway commission which is doing good work and also making a study of the question of water power development and irrigation. There is no reason why these two sovereigns, instead of standing apart and eyeing each other jealously regarding their respective jurisdictions, shouldn't co-operate in the interests both of the Nation and of the States. It is the purpose of this movement to accomplish that.

The Lower Mississippi as an Arm of the Sea

Potential Value of the Lower Mississippi to the New American Merchant Marine—How Ship Lines Can Make Immediate Use of this Waterway

BY M. VON PAGENHARDT*

CAIRO, situated at the junction of the Mississippi and Ohio Valley, and St. Louis, at the mouth of the Illinois and the Missouri, are the logical northern termini of an intensified modern Mississippi River navigation. More than 700 miles from seaboard as the crow flies, only 250 miles from Chicago, it could be declared seaboard by a stroke of the pen simply by practically applying the water rates effective between New Orleans and the Atlantic or Pacific seaboard to St. Louis itself, or, what would be the same, by the ship lines' partial absorption of the present proportional freight rate between St. Louis and New Orleans on all commodities delivered at Cairo.

Four newly developed factors make this possible. The now definitely assured American merchant marine, the creation of the United States Shipping Board, the continued and growing congestion in Atlantic seaports and the gradual modernization of the Mississippi River's floating equipment. An outlet to Gulf harbors must be arranged which is at once effective, which will from the outset commandeer the freight from a large producing area without great soliciting efforts, by making the new routing extremely attractive, and the extraordinary cheapness of transportation on the Lower Mississippi offers such an opportunity.

*Naval architect, 2073 Railway Exchange Building, St. Louis, Mo.

As a matter of fact, this Lower Mississippi between Cairo and New Orleans is so wide, so deep and has so little slope that extremists have in the past advocated a deep sea channel for seagoing ships. That is out of the question and at all times undesirable, even if the river were 24 feet deep, as both seagoing and lakegoing equipment represent too great an investment and are too urgently needed elsewhere ever to be used on the river. But the Mississippi River is in its present state of improvement sufficiently deep and wide—and has been for the last ten years—to permit a barging of freight on as large a scale as in channels connecting Raritan Bay with New York Bay, where over 28,000,000 tons were moved in the fiscal year of 1915, representing freight delivered in barges and lighters from river terminals to shipside. There is no reason why the same barging or lightering should not be carried out between Memphis, Cairo, St. Louis and New Orleans. The distance is a little greater—to be exact, over 1,000 miles greater—but that does not materially change conditions. The unique condition of the Mississipi River, running from the thickly populated States of Illinois and Iowa without any natural hindrance through a barely settled country to the Gulf, makes this river a natural, long-distance freight carrier, predestined to carry freight cheaper than over the Great Lakes.

The navigation of the Lower Mississippi, developed properly, will represent quite a new and unprecedented form of water transportation—not a transportation of freight in bulk, like ore and grain, as on the Great Lakes; not a transportation of building materials, fertilizer, rock and lumber, as on most canals—but a long-distance barging and lightering of all commodities similar to the business carried in the port channels of New York harbor, comparable only to a hundred-track railroad, to a rapid-transit line, connecting two points 1,000 miles apart, carrying all the goods carried by railroads, manufactured products as well as raw material, crude and refined oil in tank barges; in short, all freight for import and export and coastwise trade, crated and packed properly.

Long-Distance Lightering

This comparison of the almost canalized Lower Mississippi with the channels connecting New Jersey with New York harbor is no exaggeration. In either case, the freight commodities are loaded from the freight terminals into barges, the barges are towed a distance of twenty and forty miles to shipside, where they are unloaded into the ships. The terminal handling charge is the same in either case, and the only difference is the increased distance. Long distances are for the modern transportation expert almost welcome hindrances; greater distances reduce the cost per ton mile, permits the use of a larger equipment, a greater storage capacity, a greater flexibility of the movement. The actual transportation charge on the Great Lakes never exceeded 1 mill per ton-mile, and is now considerably below that amount. Translated into railroad terms, such a charge would be equal to 5 cents or 10 cents per hundred weight and represents only a fraction of the handling and terminal charges. And there will be a time when, similar to the development of the Great Lakes shipping industry, this transportation cost can be cut in two.

It should not be forgotten that the influence of the tide is visible at the mouth of the Red River, 300 miles from seaboard, and that the Cairo level is not higher than 300 feet above seaboard, representing an average slope of 3.5 inches to the mile, producing a current velocity of not exceeding 5 miles per hour and averaging 3 miles per hour. Such a river can be compared with a bay extending way inland similar to the Chesapeake Bay, with the only difference of a little more current and throughout shallower water. Not to use such an opportunity seems a crime on the natural advantages offered by nature.

General Plan

It is proposed to build towboat and barge units of 8,000 to 10,000 tons capacity each, which, controlled by the Shipping Board, radiate from the port of New Orleans, carrying railroad freight from St. Louis, Cairo and Memphis to New Orleans shipside, and *vice versa*. The actual cost of water transportation, if confined to the lower portion (St. Louis-New Orleans), a distance of 1,150 miles—similar to the distances on the Great Lakes, as Chicago-Buffalo, 890 miles; Duluth-Buffalo, 990 miles, and similar in original and eventual draft—will not exceed $2.00 per ton, or 10 cents per hundredweight, so that the ship lines could well afford to absorb the transportation charge wholly or at least to such an extent as to make the new terminals of St. Louis, Cairo and Memphis act like magnets for all export and coastwise freight originating in the whole central part of the United States, thus acting as a gradual relief of the continuously growing congestion on the Atlantic seaboard.

The establishment of such low water rates on this 1,150-mile stretch (St. Louis-New Orleans), duly filed with the I. C. C. and co-ordinated with the through and export freight tariffs of the railroads, will prove to be the only certain method to insure the ship lines visiting the port of New Orleans the required return freight. The port of New Orleans has realized the necessity of utilizing the Mississippi River long ago; this plan is offered as a further step in the river's proper utilization. The barging of freight on the Lower Mississippi will automatically reflect itself in the Upper Mississippi, Missouri and Ohio; it will further make New Orleans a redistributing center in the South for goods originating in the central part of the United States, and it will augment in leaps and bounds freight hauled by rail paralleling the Mississippi to a port of New Orleans frequented by regular ship routes. It can well be said and proven by statistics that wherever water-borne freight competes successfully with rail freight the freight hauled by rail grows in the same proportion as the freight carried by water. All students of transportation concur in this.

There never has been a real difficulty in the handling of freight wherever facilities are provided. The water transportation does not offer any real difficulty less than the navigation of the Great Lakes or on salt water. Freight once loaded in properly built, non-sinkable, non-burnable river barges, pushed by powerful, modernized steel towboats, will arrive on schedule at the other terminal point. Always in immediate vicinity of the shore, always near a telephone, never exposed to a treacherous sea, they could hardly be subject to any loss when constructed with the same care and foresight as Great Lakes or seagoing ships. There is no excuse, however, not to build them with the same care and foresight as ocean-going ships, just because they operate on a river. Only this negligence of construction accounts for the greatest part of the loss of river floating equipment.

Cost of Transportation Low

Neither can the cost of transportation be any greater than anywhere else as long as 8,000 to 10,000 tons are moved by a single operating unit of 2,000 horsepower similar in proportion to any good-sized freight boat operating on the Great Lakes or ocean, and as long as the channel is maintained at its proper depth, which it has held now for the last ten years. Neither can the difficulty be in the terminal situation. At the lower end, the port of New Orleans with its miles of improved waterfront, its docks and warehouses, its natural protection from the sea, its remarkable cheap fuel, coal from Birmingham and fuel oil from Texas and Mexico, its comparative cheap labor market and repair docks.

At the upper end, St. Louis and East St Louis, with a great number of river and rail transfer points, commonly terminals and the new permanent city dock under construction, the natural converging point of all railroads coming from east, north and west, further the various transfer points between St. Louis and Cairo, offering in their dormant potentiality an excellent opportunity to coordinate the interests of industries and transportation of inland and seaboard by the utilization of river and rail transfer.

The only difficulty is the now fortunately disappearing general lethargy in the matter of river navigation, an aloofness growing out of the feeling that past river navigation has failed and that modern river navigation has not yet demonstrated its success. It is realized that river navigation is not merely a matter of physical transportation of commodities, but that it requires a change in the country's transportation methods.

The growing need of additional transportation facili-

ties changes this attitude both on the side of railroads and shippers, and, with the awakening of this realization, all previous difficulties seem to disappear.

The problem reduces itself to a very simple equation:

1. To construct the required towing units of proper dimensions, power and security.
2. To construct or improve required terminal facilities.
3. To arrange a plan of operation of the barge line whereby the railroads participate with the ship lines under the control of the Federal Government.
4. To file a through tariff with the Interstate Commerce Commission.

The benefits accruing from this procedure are:

1. Additional transportation facilities.
2. Release of corresponding railroad facilities.
3. A saving in transportation charges.
4. A relief of the congestion in Atlantic seaports.

This solution should not be accepted as equally true for all rivers where local conditions are entirely different, but it is merely intended for the Lower Mississippi, for a "rapid transit" connection between two terminal points "inland and seaboard," on this "arm of the sea," with each towing unit representing and, therefore, relieving three to five railroad trains elsewhere, with each towing unit representing a saving in time, a large saving in transportation charges and a relief of congestion in Atlantic ports.

The reason for the inevitable success of this barging plan rests in the recommended cut in combination water and rail rates and in co-operation with the ship lines.

In the movement of freight between local points a reasonable differential of 20 or 25 percent is all that can be expected. In fact, a greater differential is hardly possible, in view of the already lowered rail rates, lowered to meet this potential water competition.

But in the movement of export, import and coastwise freight, the ship lines can well afford to absorb a part of the barging expense, as this alone will attract a sufficient tonnage to guarantee the required balanced tonnage movement, and this in turn will increase the barge tonnage to an extent where the transportation expense per unit weight is small and only a fraction of the total revenue of the through rate.

By this movement seaboard rates or "almost seaboard rates" will apply on all export and coastwise freight as far inland as St. Louis, 250 miles from Chicago. Freight is then compelled to use the river as far as the beneficial influence of this lowered export rate applies. As far north as St. Paul, as far east as Pittsburgh freight would seek the Mississippi River to reach seaboard, instead of seeking seaboard at the Atlantic. This in turn would develop the use of all other Western waterways by private enterprises; the Ohio, the Tennessee, the Upper Mississippi, the Illinois, the Missouri, the Arkansas, the Black River and the Red River, in order to join with their own barges the grand procession of towing fleets on the Lower Mississippi River and benefit from the natural advantage of low cost of transportation on this waterway, which in reality is an open arm of the sea.

The Fallacy of Concrete Ships

Optimism Regarding Success of Large Ocean-Going Concrete Vessels at Present Unjustified

BY H. A. EVERETT*

WE are hearing much now-a-days about ships to be built of reinforced concrete, and as a rule the presentation of the subject has a very unprofessional bias toward extreme optimism. This is not to be wondered at when it is considered that those most directly interested in the new project fall into two classes, both of which are interested in selling something—first, the cement companies, who naturally are interested in anything which augments the usefulness and sale of cement; and, second, the constructor who has a system of construction which he wishes to sell or build under, with consequent remuneration to himself. We rarely read anything that is not laudatory to this so-called new system, and the absence of adverse comment is misleading in that it gives the impression that there *is* none. This is unfortunate, as both sides of any question are always desirable, and I wish to direct attention to a few features wherein this construction is either deficient or open to serious question.

It may be well to first note that there has not yet been built and put in operation a seagoing concrete ship as large as 200 feet length. The entire construction up to the beginning of this year consisted of barges, scows, canal boats and small craft under 200 feet length, the majority of which are intended for quiet water or coastwise operation.

One need not deny the usefulness of reinforced concrete for heavy barges, etc., for still-water usage, though even there our experience with those built for the Panama Canal was not entirely satisfactory, but when we begin to talk of large seagoing ships—and by large let us say anything over 250 feet, though that is woefully small for steel ships—we then are approaching an absolutely untried field and one which, if discouragement and disaster are to be avoided, must be approached sanely and gradually.

The present time is the psychological one to advance any project for ship construction which will use materials and labor that do not enter into the construction of the regular steel ships because of the immense pressure which the war has put upon that industry, and we are now willing to try out projects that in times of less urgent need would not be considered; moreover, economic conditions have forced an artificial level to both material and labor for steel fabrication. There are bound to be, therefore, sporadic cases of completed units which, while pointed to with pride as demonstrating the complete success of the future industry, are nevertheless only experiments, simply demonstrating the possibility of actually constructing such a unit and giving no information whatever as to the later success of the vessel from the technical or economic point of view. We are informed, for instance, of large vessels (up to 3,000 tons) being built in Sweden, and also of a large vessel (5,000 tons) being built in this country, all of which certainly are in the above-mentioned category; and while those financing the proposition and the

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

construction deserve the greatest credit for their experimental generosity and engineering ingenuity, they are certain to be confronted with many unlooked-for defects and difficulties.

One of the best gages for measuring the merit of new propositions in hull construction is the attitude of the various large classification societies; and while they have been accused in years past of undue conservatism, their attitude since the war and its attendant abnormal demand for new construction has been as progressive as is consistent with safety of life at sea. Of these, the majority will not class this construction for ocean-going, self-propelled units; some have been willing to class vessels of sizes less than 150 feet length for ocean-going service, but for a very brief term subject to extension on satisfactory survey, and societies in Great Britain, Denmark and Norway have recognized its usefulness for non-propelling barges, etc.

Principal Advantages Claimed

The advantages claimed by the most optimistic reinforced concrete advocates may practically be boiled down to four major claims: 1, availability of material; 2, availability of labor; 3, cheapness of repair and maintenance; 4, permanence of construction. Of these, the first (availability of material) may go unchallenged. It is an advantage.

The second (availability of labor) is by no means so readily accepted. There is a serious shortage in this country now of good carpenters accustomed to working on reinforced concrete; in addition, the work on ships is a highly specialized form of concrete construction requiring especially good fabrication and a corps of artisans whose training must be specialized to nearly the same extent as the ordinary workman on a steel hull, whether the work be done with a "cement gun" or the more orthodox method of using forms.

Cheapness of repair, the third item, is questionable, for the proper repairing of a reinforced concrete structure designed to be highly stressed is not simply a matter of putting on a few hodfulls of cement. If the structure has been seriously damaged the reinforcing must be repaired, and it is improbable that the cost of repair work will be less than for steel construction.

Permanence of Concrete Needs Verification

Considering the fourth claim—i. e., permanence—we are told that the ship is to be a "monolith," a "rock," and "with all a rock's permanence." Anyone who has to do with concrete structures, even ashore, realizes that any part subjected to constant shock and abrasion deteriorates. When one comes to a seagoing structure we have vastly augmented deteriorating forces, due to the repeated varying stresses of large magnitude, the effect of salt water and dockage and handling, wear and tear.

In a structure as complicated as any ship of reasonable size must be, there are numerous webs and corner connections which, as in an iron casting, are apt to suffer severe stress and fracture from expansion and contraction due to temperature change only. In as relatively simple a structure as a dry dock, trouble is experienced in allowing for expansion and contraction due to changes of temperature, and with a complicated monolith like a ship there is sure to be cracking of cement at such places, with the attendant rapid deterioration of the reinforcing.

Much more subtle and persistent, however, is the deterioration of the whole structure due to its immersion in salt water. In a very illuminating article recently published in the *Journal of the Franklin Institute** our attention is directed to the serious effect of salt water on reinforced concrete.

The author first calls attention to an investigation by the U. S. Bureau of Standards (Technical paper 12) on the "Action of the salts in alkali water and sea water on cement," which found that any cement mortar may be destroyed if a sufficient amount of salt accumulates and crystallizes out. He calls attention to the markedly prevalent cracking of reinforced concrete structures in the Philippines reported by J. L. Harrison, district engineer, Iloilo. (Bulletin of Bureau of Public Works, October, 1916), of which a study "showed no structure showing rusted steel to be free from salt," and continues as follows: "It is clear that reinforced concrete which comes in contact with brine or sea water, unless rendered absolutely impervious, will commence to deteriorate as soon as the brine comes in contact with the reinforcing rods; for, as both iron oxide and the hydrated oxide occupy a larger volume than the corresponding amount of iron, there will be developed an enormous expansive force which is sufficient to crack the strongest concrete and force it away from the reinforcing rods. The more porous the concrete, the more rapidly will this action take place. Indeed, the writer is familiar with cases of cinder concrete structures, in contact with brine, which have shown signs of advanced deterioration at the end of a year.

"Regarding the waterproofing of concrete, it should be pointed out that an impervious concrete is probably never obtained outside the laboratory. The average concrete is practically never waterproof. Although there are many substances on the market for rendering concrete waterproof, the majority of them are far from satisfactory. A number of such instances has been investigated by Brown (*The Electrician*, 69, 615, 1912), who points out that all waterproofing materials will sooner or later hydrolize, crack or disintegrate.

"Since most concrete is more or less porous to moisture, and since iron undergoes gradual decomposition in the presence of salt water, with consequent expansion in volume, it is to be expected that reinforced concrete which comes in contact with brine or salt and moisture will ultimately disintegrate. It is not surprising, therefore, to find throughout the country reinforced concrete piers, sea walls and buildings in the neighborhood of the ocean in various stages of deterioration. The cracks which occur in such concrete usually run parallel to the reinforced rods. These cracks are very narrow at first, but as the decomposition of the iron progresses they become iron-stained, gradually increase in width, and finally the concrete is forced so far from the reinforcing rods by the pressure of the accumulating iron oxide that large pieces of it break off."

The paper ends with a list of the citations of many cases, giving photographs, in which deterioration and disintegration of the concrete has been due to the action of salt water superficially applied.

In view of this, it is hard to see any ground for the claims of such remarkable longevity as are advanced, and the slogan "concrete for permanence" certainly needs verification before being accepted as applying to ships.

A ship is built to carry cargo, and anything which detracts from her carrying capacity is an economic loss. Concrete ships are bound to be much heavier than steel or wooden ships when the size is over 100 feet length. A recent estimate* of a specific reinforced concrete barge 120 by 28 by 8 feet put out by the designers gave the weight as 259 tons, as against 135 and 151 tons for

* "The Deteriorating Action of Salt and Brine on Reinforced Concrete," by H. J. M. Creighton, *Journal of the Franklin Institute*, November, 1917.

* "Reinforced Concrete for Shipbuilding," by Allen Hoar, Marine Engineering, July, 1917.

wooden and steel construction for same barge, and as larger and more complex units are discussed there is nothing to indicate a transference of this debit to the side of the steel ship. One has only to bear in mind that the tensile strength of reinforced concrete is *that due to the steel in it* to realize that for equal sized vessels there must be as much steel in the strength members of the concrete ship as in the steel ship, and the concrete becomes so much additional weight which must be paid for in reduction of weight elsewhere or in reduced cargo-carrying capacity. The rule of the Union of Danish Engineers (one of the few technical bodies formulating rules for reinforced concrete ships) limits the stress in the steel work to 8 tons per square inch, when the calculation is made in the orthodox way, as for steel ships, by assuming the ship on a wave equal to her length and loaded with a homogeneous cargo. Consider this in comparison with the normal allowance for plain steel ships of 6 or more tons. Moreover, the principal stresses which the seagoing hull structure must withstand are tensional, which is the sort of stress that reinforced concrete is least suited for.

The absurd extent to which the optimism of the proponents of concrete for ships has led them is illustrated in the following list of reasons recently published "Why concrete fits shipbuilding needs." In parallel columns I have ventured equally brief comments, which, like the original list, are given without experimental or engineering evidence, but which, unlike the original list, can be verified by engineering experience:

CONCRETE SHIPS	STEEL SHIPS
1. Concrete ships are fireproof.	So are steel ships.
2. Wood-boring worms cannot attack the hull.	Nor a steel ship.
3. Concrete ships are ratproof.	So are steel ships.
4. Concrete ships require practically no maintenance.	Doubtful; authoritative operating reports are lacking.
5. Construction methods are economical and the cost is low.	The cost is higher than for steel or wood.
6. Concrete ships can be built quickly.	Questionable; but so can steel or wood.
7. Concrete ships will neither rot nor rust.	They will deteriorate.
8. Calking, painting and similar maintenance of the hull is unnecessary.	Questionable.
9. Concrete ships will withstand very rough usage.	Not borne out by many cases.
10. Materials required may be obtained readily anywhere at low cost.	Granted.
11. Less labor is required and cheaper labor may be employed.	Questionable.
12. There is no likelihood that the hull of a properly designed concrete ship will buckle.	If properly designed to withstand seagoing stresses, the weight is excessive.
13. Because of the smooth surface and the absence of angular projections, skin friction is greatly reduced.	The difference in skin friction, if any, is in favor of the steel ship well painted.
14. Concrete vessels may be floated before completion.	So can steel or wooden.
15. Concrete vessels are lighter than similar ones of wood.	All figures available give the reverse conclusion.
16. Barnacles and other sea growths find conditions unfavorable to their growth.	Questionable.

To sum up briefly we are justified in expecting success for reinforced concrete construction for barges, still-water craft and perhaps small ocean-going craft of simple form, but are entirely unjustified at the present time in expecting large ocean-going craft to be successful, and should not be led astray by undue optimism.

A dirty gage class is dangerous and when cleaning it a wooden stick with waste should be used and never a wire or any metal rod.

When checking a fire by opening the fire door it is not wise to open it wide all at once. Open it a little at a time or you may start your tubes leaking.

British Marine Engineering Design and Construction Committee

As a result of the conference convened by the Institution of Naval Architects, a committee has been formed consisting of representatives of the various shipbuilding and marine engineering societies, the Board of Trade and the registration societies "to standardize rules governing the design and construction of marine engines and boilers upon a practical and scientific basis, so that they may be acceptable to shipowners, the Board of Trade, the classification societies and other interests concerned."

There are at present four different sets of rules in force governing the design and construction of marine engines and boilers, all of which aim at securing safety and efficiency of marine machinery, and it is believed by many that one set of suitable rules having a scientific and practical basis should be secured for all purposes. It is for the preparation of such rules that the committee has been formed. The committee is composed of the following members:

Institution of Naval Architects.—A. E. Seaton, consulting engineer (chairman); Professor W. E. Dalby, M.A., F.R.S., dean and professor of engineering, Imperial College; H. Barringer, consulting engineer; R. Leslie, superintendent engineer of the Peninsular and Oriental Company.

Institution of Engineers and Shipbuilders in Scotland.—James Brown, director of Scotts' Shipbuilding and Engineering Company; A. Cleghorn, director of the Fairfield Shipbuilding & Engineering Company, Ltd.; J. S. Kincaid, director of John G. Kincaid & Company, Ltd.; W. G. Weir, director of David Rowan & Company.

North-East Coast Institution of Engineers and Shipbuilders.—F. T. Dickinson, chairman of John Dickinson & Sons, Ltd.; Andrew Laing, C.B.E., managing director of the Wallsend Slipway & Engineering Company, Ltd.; D. B. Morison, managing director of Richardsons, Westgarth & Company, Ltd.; Professor R. L. Weighton, M.A., professor of engineering, Armstrong College.

Institute of Marine Engineers.—B. P. Fielden, superintendent engineer, Atlantic Transport Company; T. McLellan, superintendent, the Eagle Oil Company; W. J. Veysey Lang, superintendent engineer, Watts, Watts & Company, Ltd.; A. Walker, superintendent engineer, Strick & Company, Ltd.

Liverpool Engineering Society.—W. J. Willett Bruce, superintendent engineer, White Star Line; Sterry B. Freeman, superintendent engineer, Alfred Holt & Company; J. Hamilton Gibson, engineering manager, Cammell, Laird & Company, Ltd.; J. B. Wilkie, superintendent engineer, Elder, Dempster & Company, Ltd.

Board of Trade (Marine Department).—T. Carlton, engineer surveyor in chief.

Lloyd's Register of British and Foreign Shipping.—J. T. Milton, chief engineer surveyor (deputy chairman and honorary treasurer).

British Corporation for the Survey and Registry of Shipping.—W. Rowan Thomson, member of the committee.

Bureau Veritas, International Register of Shipping.—John Gravell, chief representative in the United Kingdom.

Barrow District.—J. McKechnie, managing director, Vickers, Ltd.

Belfast District.—C. E. Allan, director, Workman, Clark & Company, Ltd. (corresponding member).

Steel Makers.—B. Talbot, managing director, Cargo Fleet Iron Company; R. J. Butler, C.B., director, John Spencer & Company.

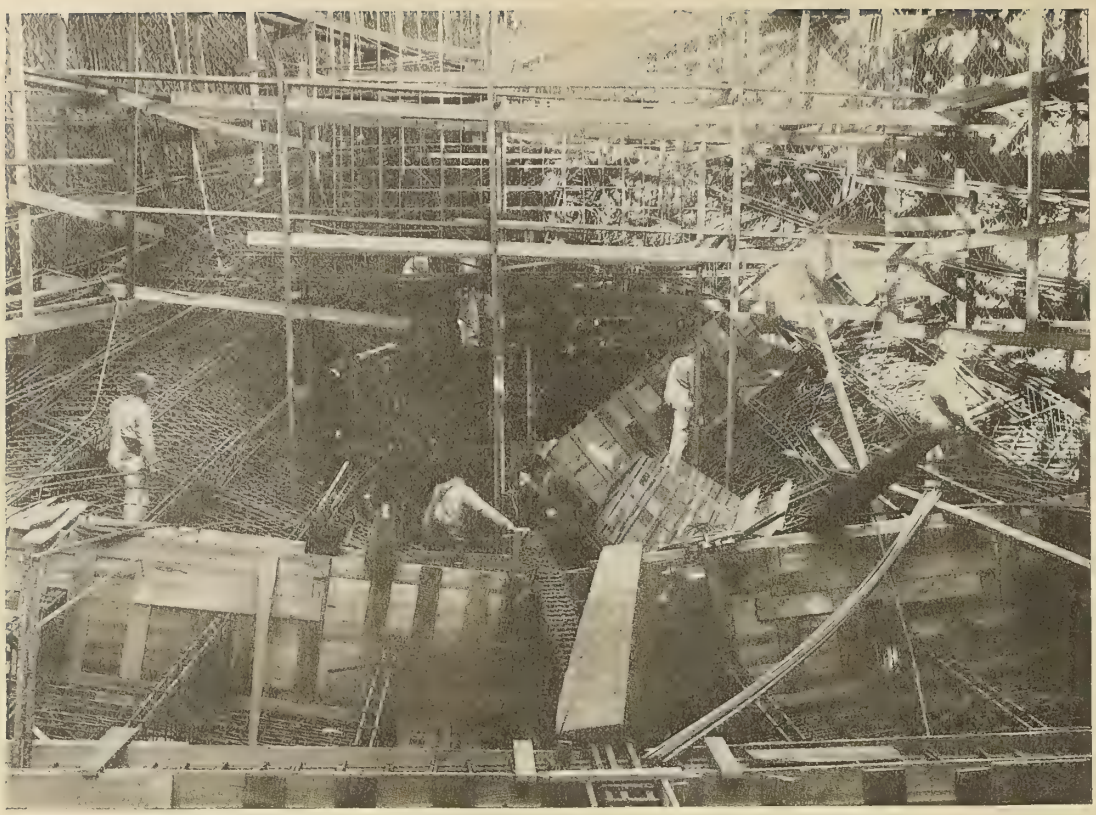


Fig. 1.—Building Molds Around Steel Work for Pouring Concrete

Reinforced Concrete Cargo Steamer

Plans and Specifications of 5,000-Ton Vessel Building by San Francisco Shipbuilding Company in California

REFERENCE has already been made in previous issues to the construction of a 5,000-ton reinforced concrete steamship by the San Francisco Shipbuilding Company at Redwood City, Cal. In our last issue photographs were published showing the progress of construction of this vessel, while in this issue we are able to reproduce the general plans of the vessel, together with the following data from its specifications:

The vessel is a single-screw steamer with straight stem and cruiser stern, rigged with two pole masts fitted with cargo booms. The propelling machinery is to be located aft, while the deck officers will be quartered in a house amidships, and the engineers, steward and crew in houses aft.

The general dimensions are as follows:

Length between perpendiculars	320 feet
Length over all	336 feet 3 inches
Breadth, molded	44 feet 6 inches
Depth to main deck	30 feet
Depth to lower deck	21 feet
Deadrise	9 inches
Designed load draft	24 feet
Deadweight carrying capacity at above draft	5,000 tons
Horsepower	1,750
Speed	10 knots

The hull is of reinforced concrete, the reinforcement consisting of deformed steel bars accurately placed in molds and carefully wired together, while the concrete will be carefully poured into the forms and well puddled with steel rammers. In addition to the bar reinforcement, all of the outside shell and deck will be further reinforced by 6-inch by 6-inch mesh No. 6 galvanized iron fabric placed ¾ inch from the outside surface of the concrete.

The outside mold for the hull was built, first using 2-inch by 4-inch studs inside and outside with ⅞-inch sheathing. The studs were placed 2 feet on centers and wired through every 18 inches. Wood spreaders are used throughout to be taken out after the concrete is poured, great care being exercised to see that all of these spreaders are removed as the pouring progresses.

Along the sides of the building ways, about 2 feet outside the mid section line, were erected 8-inch by 10-inch timbers 36 feet long, trussed across at the top 16 feet on centers. These timbers were accurately set and carefully alined, since the general interior dimensions were taken from their center lines.

The specifications provide that no concrete is to be stripped until the entire structure is poured and set for at least thirty days.

Materials

The large aggregate consists of No. 4 crushed limestone not exceeding ¾ inch and absolutely free from dust. The sand used consists of Grant Gravel Company's topping sand accurately graded from ¼ inch down to that which passes a No. 60 sieve.

The cement used is Portland cement of local manufacture, especially ground according to directions of the Smith Emery Company's testing engineers, special care being taken to have a minimum of magnesium in its com-

5,000-TON REINFORCED CONCRETE CARGO STEAMSHIP

Building at Redwood City, Cal., by San Francisco Shipbuilding Company

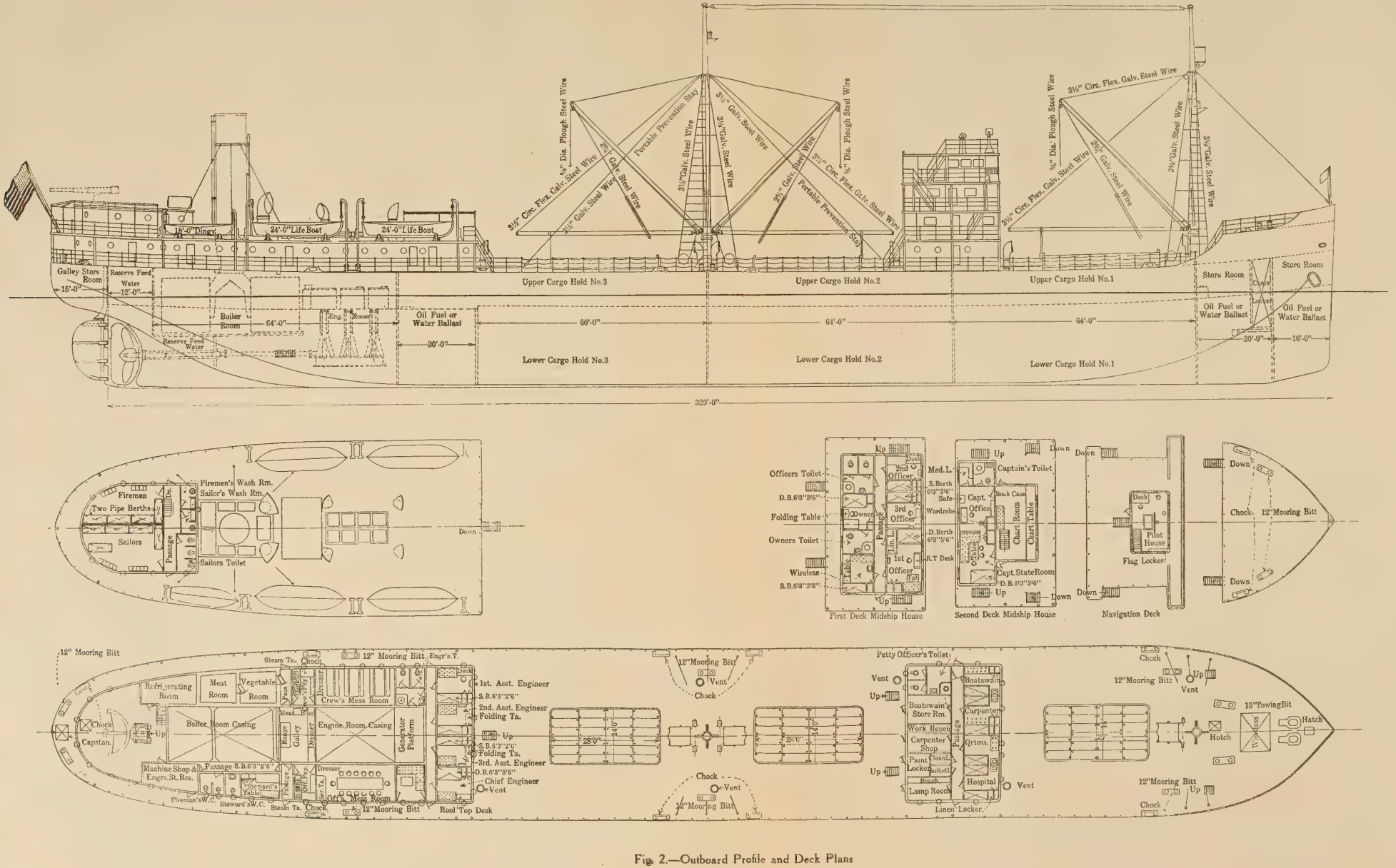


Fig. 2.—Outboard Profile and Deck Plans

position. All of the cement is carefully tested at the mill and again on the job.

The material will be waterproofed by an integral waterproofing material, consisting of a special compound supplied under the directions of a competent chemist supervising the work.

The proportions of the cement aggregate are as follows: One part cement; 1½ parts fine aggregate; two parts coarse aggregate.

The concrete is mixed in a rotary batch mixer with pure fresh water free from all chemical impurities, as little water being used as possible to make the concrete flow.

The concrete is carefully poured into the forms and well puddled with steel hammers. During the pouring, the sides of the outside forms of all walls and beams are hammered to insure the density of concrete at the surface and the prevention of voids.

The hull is so located on the building ways that the bottom is 6 feet above the ways and carefully shored. After the concrete has set a sufficient length of time, sections 8 or 10 feet in length will be stripped and the outside coating applied. As soon as the outside coating has set and is finished, the blocks for launching will be placed under the finished portion of the hull, and sufficient scaffolding erected to hold the structure in place. When this is done another alternate section will be stripped, and the same operation repeated until the full length of the boat is resting on the launching ways.

After the surface is stripped and carefully sand-blasted to insure a good, clean bond, an outside finish will be applied with cement guns. The mixture to be used will be one part cement, two parts river sand free from mica and other impurities, the materials to be mixed dry and applied under pneumatic pressure, adding the water at the nozzle. This coating of "gunite" is not to exceed ½ inch in thickness.

As soon as this outside skin has attained its final set, which should be in four or five hours, it will be carefully wet down and kept soaked with water for a period of five days. When the outside skin is sufficiently set it is to be rubbed down with emery blocks by hand until the surface is smooth.

General Arrangement

The hull is subdivided into nine watertight compartments by eight transverse bulkheads of reinforced concrete. The upper deck is of reinforced concrete, while there is a lower deck made of wood. Three large cargo hatches are provided, served by cargo booms of 3 tons capacity, fitted to the masts and operated by double-drum steam winches.

Fuel oil tanks are located in the hold, one forward of the engine room bulkhead and one aft of the collision bulkhead, as shown on the plan. Fresh water will be carried in the hold aft of the boiler room bulkhead, and also in wooden tanks in the engine and boiler room. The forepeak tank will be arranged for use as a ballast or fuel tank.

The stem of the vessel is of reinforced concrete, covered with a ⅜-inch steel plate shoe. The stern frame is of cast steel fitted in two sections. The rudder is of the single-plate type.

The engine and boiler casing in the 'tween decks is of reinforced concrete, while above the main deck it will be of wood lined with sheet iron. The chain locker, located aft of the collision bulkhead, is also constructed of reinforced concrete.

Propelling Machinery

Propulsion will be by a single screw of cast iron of the four-bladed solid type about 14 feet 7 inches diameter, driven by a triple-expansion surface condensing engine, with cylinders 24 inches, 39 inches and 65 inches diameter, with a common stroke of 42 inches, supplied with steam from two three-furnace, single-ended Scotch boilers, each 14 feet 6 inches diameter by 12 feet 9¼ inches long. Piston valves will be fitted to the high and intermediate pressure cylinders of the main engine, while a double-ported slide valve will be fitted to the low pressure cylinder. The valves will be actuated by Stephenson link motion with double bar links. The condenser, which will be independent of the engine framing, will have about 2,000 square feet of cooling surface. The air pump, two feed pumps and two bilge pumps will be driven by a pump beam from the low pressure crosshead of the main engine, while the circulating pump will be of the centrifugal type direct connected to a vertical steam engine.

The crankshaft of the main engine will be 13 inches diameter in the journals and 13¾ inches in the webs. The

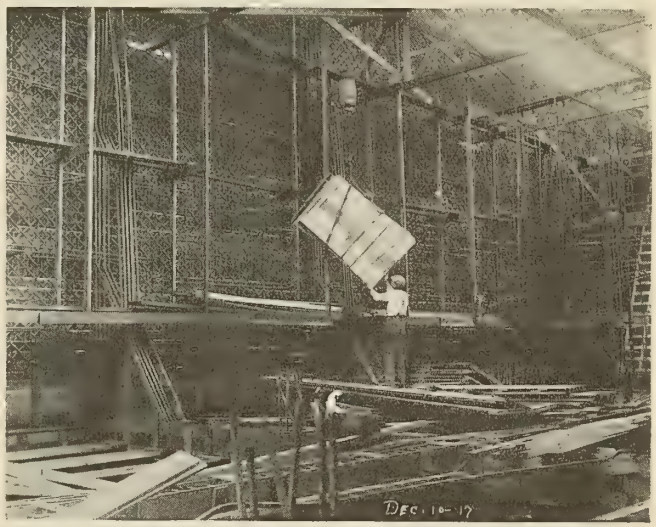


Fig. 3.—Interior of Hold with Reinforcement in Place

thrust shaft will be 13¼ inches between the collars, tapered at each end to about 13 inches diameter. The line shafting will be 12½ inches diameter and the tail shaft of 14 inches diameter.

The following pumps will be provided:

Pumps

One double acting duplex ballast pump and one double acting feed pump to be supplied, each with chamber, bucket, valve seats and rod of brass, ballast donkey valves of india rubber, and those of feed donkey of brass.

Duplex ballast pump to be 12 inches by 8½ inches by 12 inches, or equal capacity, to draw from sea, bilges and ballast tanks, and to discharge into condenser, ballast tanks, fire main, overboard, and to sanitary line.

Duplex feed pump will be 10 inches by 6 inches by 12 inches, or equal capacity, and draw from condenser, fresh water tanks, from sea and from boilers, and to discharge overboard, to feed heaters, to boilers, auxiliary line to donkey boiler and to fresh water tanks.

There will also be installed one duplex oil trimming pump, 6 inches by 5¾ inches by 6 inches, which will draw from the main oil fuel tanks and deliver to settling tanks in engine room.

There will also be provided two duplex fuel oil pumps, 5¼ inches by 3½ inches by 5 inches, to draw from settling tanks, and deliver to fuel oil heaters and boilers.

The vessel will be equipped with an electric lighting plant, refrigerating plant, steam heating system and steam steering gear.

The Beardmore Marine Engine*

Two-Cycle, Hot-Bulb Type Oil Engine Developing 160 Brake Horsepower at 280 Revolutions per Minute

ONE of the outstanding developments of recent times in marine propulsion is undoubtedly the greatly extending sphere of application of the semi-Diesel or hot-bulb type of oil engine, together with the rapid increase in power developed per unit. Quite recently this type of engine was universally regarded as being suitable for the development of only relatively small powers, say 25 brake horsepower to 30 brake horsepower per cylinder, but recent modifications in design and the virtues of rigid simplicity have brought it greatly into favor even for powers up to 130 brake horsepower per cylinder.

The great majority of marine semi-Diesel engines have points of similarity in the system upon which they work, and practically all are of the two-stroke cycle, utilizing the enclosed crank chamber for the compression of scavenging air. The "Beardmore" engine, which we illustrate on page 67, has been designed essentially to meet the peculiar requirements of marine propulsion, and is the result of much experience with this type of engine installed in yachts, coasters, lighters and fishing vessels. It is particularly suited to consume fuels ranging from 0.8 to 0.9 specific gravity, but can be adjusted to use either slight lighter or heavier oils. Working on the two-stroke cycle, it develops 160 brake horsepower while running at 280 revolutions per minute. This relatively slow speed of revolution is, of course, conducive to high propeller efficiency. As all bearing surfaces are liberal and materials carefully selected, an outstanding feature of the engine is its capacity for long and hard service. The engine is directly reversible by means of compressed air, and requires no disconnecting clutch between the engine and propeller, the latter advantage being one that appeals very strongly to marine engineers in general and oil-engine users in particular. Figs. 1 to 3 on the opposite page give sections and elevations of the engine, Figs. 5 to 9 are details of the main valves, and Figs. 10 and 11 are diagrams from the cylinder and crank chamber.

Cycle of Operations

In the main engine there are four cylinders, each 11 inches diameter by 15 inches stroke, and the cycle of operations may be briefly described as follows, the reference numbers being those shown on the section of one of the cylinders in Fig. 1: During the upward stroke of the piston, air is drawn through non-return valves into the crank chamber 1, to be compressed on the downward stroke and admitted into the cylinder at the correct moment through scavenging air ports located directly opposite to the exhaust ports 2. These ports are covered and uncovered by the piston, on the top of which a deflector is arranged, to give to the air blast the direction most suitable for efficient scavenging. While the under side of the piston is performing the functions of a scavenging air pump, the upper side compresses the contents of the previously scavenged cylinder on the upward stroke in preparation for the downward or power stroke. A separate fuel pump is provided for each cylinder, and once in each revolution of the engine fuel is sprayed directly into the combustion chamber 3, through pulverizing nozzles fitted with automatic check valves, and ignition is obtained through the fuel impinging on the heated surface of the combustion chamber. The combined heat of compression and combustion sustains the temperature necessary for ignition, and consequently no blow lamps are required except for a few minutes before starting the engine. The various operations of the working cycle can be clearly understood from an inspection of the indicator diagrams taken from the cylinder and crank chamber and reproduced in Figs. 10 and 11, and the sequence and correlation of the operations will be appreciated. These diagrams show the excellent results obtainable by careful design based on extensive experience.

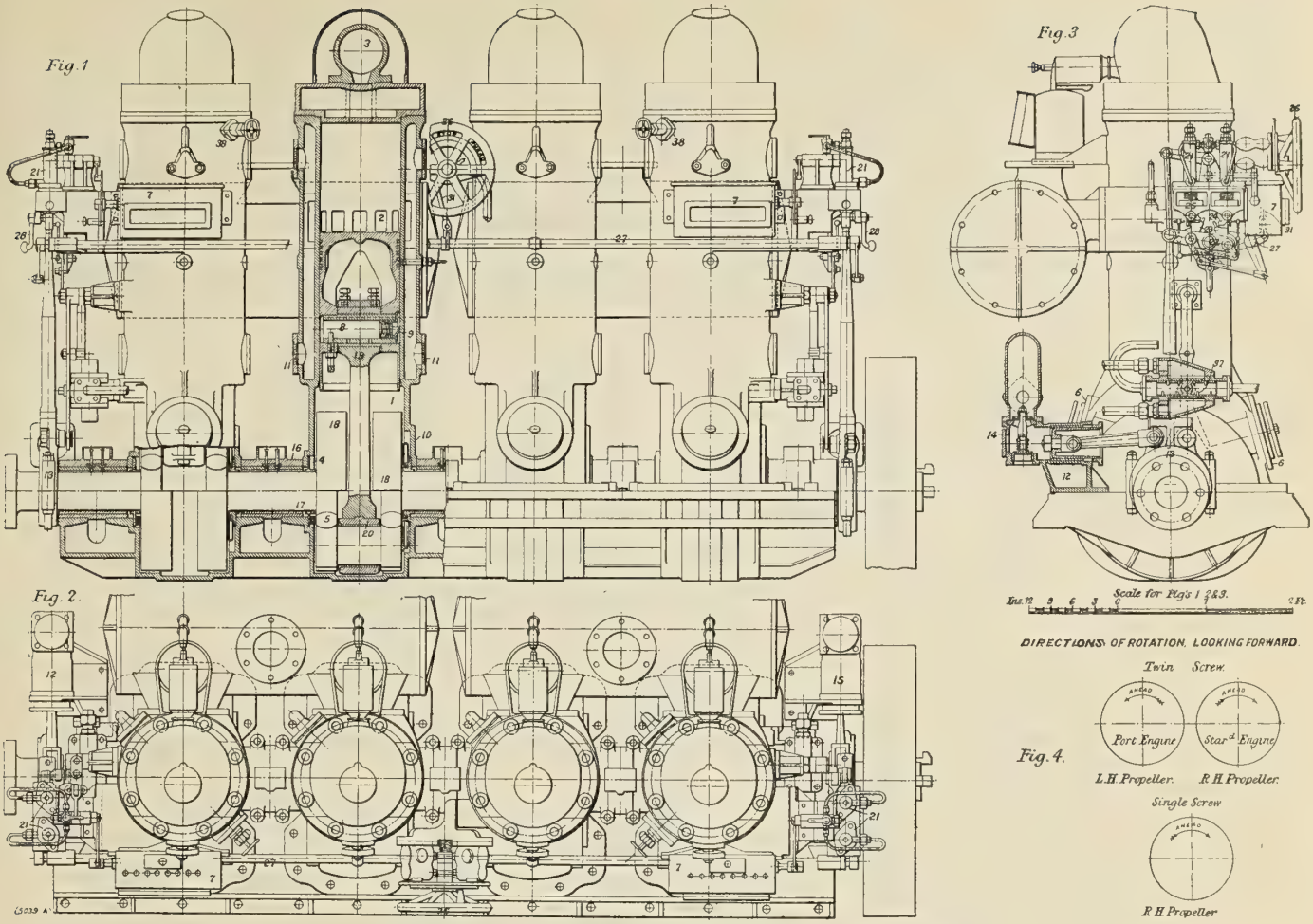
Scavenging

As already stated, scavenging air is compressed in the enclosed crank chamber, and in order to obtain the necessary quantity of air at a suitable pressure for efficient scavenging the volume of the crank chamber is reduced to a minimum and the whole is made as nearly as possible airtight. The latter condition is difficult to attain where the shaft passes through the walls of the crank chamber, and the method adopted on this engine is interesting. A bronze ring, 4, Fig. 1, is carefully bedded to the body of the shaft close to the crank-web, and is pressed against a machined surface on the inner side of the crank chamber by springs, 5, between the ring and crank-web. The ring revolves with the shaft, and consequently wear is confined to the flat surface and automatically corrected by the springs, which exert sufficient pressure to prevent the ring leaving its face when the air pressure in the crank chamber is below that of the atmosphere. Since inefficient scavenging is necessarily accompanied by loss of power and waste of fuel, the problem of rendering the crank chamber airtight is of the utmost importance and has received much attention from engineers, but perfect airtightness has not yet been achieved. Channels are therefore provided on this engine between the main-bearing cap and the side of the crank chamber to allow the free escape of any trifling leakage past the ring, and thus to prevent the possibility of interference with the lubrication of the main-bearing bush. Air is admitted to the crank chamber through grids at the front and back covered by flexible plate valves backed by light springs, and these are mounted on large doors, 6, Fig. 3, the removal of which gives easy access to the crank-pin bushes.

Lubrication

It will be obvious that with this enclosed type of crank chamber, which is utilized as a scavenger pump, forced lubrication cannot be applied to the crank-pin bearings, because a large quantity of the overflow would be taken up by the air and eventually find its way into the working cylinders, with the attendant result of excessive consumption of lubricant. The question of lubrication, therefore, is a difficult one, but has been solved in the "Beardmore" engine in a most satisfactory manner. A forced sight-feed system, with separate plunger pump and oil tube to each point where lubrication must be positive and regular, has been adopted, and by this means the quantity of lubricant supplied to any point is definitely controlled by the attendant, while any interruption of the supply due to a choked tube or faulty valve can be instantly detected and the sight glass shows clearly which point is affected. Two eight-feed lubricator boxes, 7, Figs. 1 to 3, are em-

* From *Engineering*.



Sections and Elevations of Beardmore Marine Semi-Diesel Engine

ployed on this four-cylinder engine, and the reciprocating drive is obtained from the fuel-pump actuating gear. The sixteen feeds are distributed as follows: three to each cylinder and one to each crank pin. The cylinder feeds are disposed in such a way as to lubricate the entire working surfaces of the piston and cylinder wall, while one feed also serves to lubricate the gudgeon pin. The gudgeon pin is hollow, as shown at 8, Fig. 1, and is secured in place by a screwed pin, which is split at the point to prevent the possibility of falling out. At the other end of the hollow gudgeon pin is a plunger with a scoop end, 9, Fig. 1, which is forced against the cylinder wall by means of a spring and collects oil from the lubricating tube already mentioned. The feed for the crank pin is carried through the side of the crank chamber and led to the interior of a revolving ring, 10, Fig. 1, from which the oil is carried by centrifugal force to its destination. The lubrication of the main bearings is effected by means of siphon tubes—an accepted marine practice.

Details of Construction

The cylinders are cast separately and are extended below the working barrels to form the upper halves of the crank chambers. The cylinder bodies are completely encircled by ample water jackets, and large access doors, 11, Fig. 1, are provided to facilitate the removal of any deposit which may be formed therein. The cylinder covers and silencers are also jacketed, and the circulating water is supplied by a reciprocating pump, 12, Figs. 2 and 3, placed at one end of the bed-plate and actuated by an eccentric, 13, Figs. 1 and 3, on the crankshaft. The pump body is of cast iron lined with brass and is provided with brass non-return suction and delivery valves, spring-loaded escape valve and a large cast iron air vessel. Access to the suction valve is obtained by removing door 14, Fig. 3, and to the delivery valve by removing the air vessel. A bilge pump, 15, Fig. 2, of the same size and design, is placed at the other end of the bedplate and similarly operated.

Bedplate and Crankshaft

The bedplate is cast in one piece, with suitable flanges for bolting down to the seating in the ship, and is provided with machined recesses to receive the main bearing bushes. The main bearing caps, 16, Fig. 1, are readily accessible for removal, and when removed the bushes, 17, Fig. 1, which are made eccentric to the shaft on their outer diameter, can easily be slipped from under the shaft without disturbing any gear whatever. The bushes are of Admiralty quality gun-metal with white metal lining.

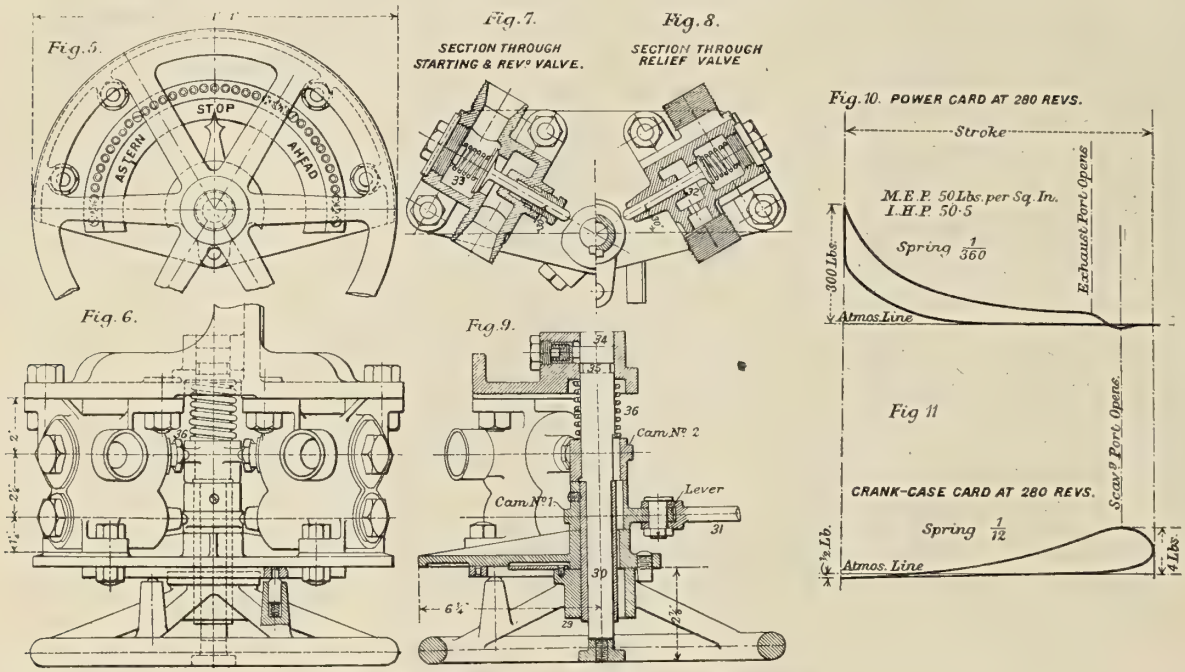
The crankshaft is a solid forging of Siemens-Martin steel, and is machined all over. Large balance-weights, 18, Fig. 1, are secured to the crank-webs, and these not only give to the engine an evenness of turning moment and a desirable freedom from vibration, but also serve to reduce the clearance volume of the crank chamber, and thus increase the scavenging efficiency.

The connecting rods are machined steel forgings fitted with adjustable bearings at top and bottom ends. The top end, 19, Fig. 1, of each rod is of special design to allow of easy adjustment, and the bearing surface is of phosphor-bronze. Examination of the gudgeon pin and bush, also piston and piston rings, is obtained by removing

the cylinder cover and drawing the piston upwards after the lower end of the connecting rod has been disconnected. The marine type crank pin bush, 20, Fig. 1, is of Admiralty quality gun-metal, with white metal lining, and is accessible for examination or adjustment through the doors, 6, Fig. 3, arranged at the front and the back of the crank chamber.

Fuel Pumps

The four fuel pumps, 21, Figs. 1 to 3, are grouped in pairs at opposite ends of the engine and are operated by the eccentrics, 13, Figs. 1 and 3, previously mentioned in connection with the water pumps, a horizontal rocking lever, 22, Fig. 3, fulcrumed at its center, being employed to carry the fuel-pump strikers, 23, Fig. 3. The stroke of the strikers is, of course, very much in excess of that to be communicated to the fuel pump plungers, and consequently the discharge of fuel to the combustion chambers is restricted to a very short period. The idle portion of the stroke is utilized for governing purposes, and as the action of one is identical with the others it will be sufficient to describe one. The pump striker is pivoted on the rocking lever and is free to rotate but for the action of a light spring, 24, Fig. 3, drawing it towards its guide. On the face of the guide a step is formed which throws the striker off its original course, but as this effect is counteracted by the spring already mentioned the engine speed determines whether the striker shall hit or miss the pump plunger. The tension of the spring can be adjusted to cut out at any engine speed, and when that adjustment has been made the following conditions are fulfilled: At all engine speeds up to and including a predetermined limit the fuel pump delivers a definite quantity of fuel during a definite fraction of each engine stroke, the quantity delivered being entirely under the control of the attendant on the starting platform, and when the engine speed exceeds the predetermined limit the pump automatically ceases to operate until the normal speed is regained. When it is remembered that all four fuel pumps are alike, it will be readily understood that the system of governing is very sensitive and quick in action, and it is worthy of note that the tension of the governor springs can be adjusted either individually or collectively while the engine is running. The maximum quantity of fuel to be delivered at full power is determined by a screwed collar, 25, Fig. 3, on the lower end of the pump plunger. By turning this collar to right or left the plunger is raised or lowered relatively to the striker, and consequently the stroke of the plunger is limited, but this adjustment, of course, is only required when tuning the engine to suit a given quality of fuel and should not be used for any other purpose. The ordinary control of the engine speed is effected through a hand wheel, 26, Figs. 1 to 3, placed at the center of the engine. The fuel pump strikers are mounted on eccentrics in the rocking lever, and these eccentrics are connected by a system of levers and links to a horizontal shaft, 27, Figs. 1 to 3, running along the front of the engine. Any rotary movement of this shaft is therefore transmitted to the eccentrics, and the strikers are thus raised or lowered collectively according to the direction of movement imparted to the horizontal shaft by the hand wheel. Very fine graduations of the engine speed are obtainable in this way. A priming handle, 28, Fig. 1, is fitted to each fuel pump for charging the pipes before starting, and any pump can be put out of action instantaneously by raising the handle to a horizontal position. Should it become necessary for a pump to be put out of action permanently the screwed collar already referred to in connection with tuning meets this requirement, and when thus cut out the suction and delivery valves and springs can be removed for examination by simply disconnecting the delivery pipe and screwing out the plug in the top of the pump barrel.



Details of Main Valves and Indicator Diagrams

Starting and Reversing

Starting and reversing are effected by means of compressed air and the details of the gear, Figs. 5 to 9, show how all the operations of the engine are controlled by a single hand wheel. The hand wheel is mounted on a sleeve, 29, Fig. 9, which also carries a lever and cam No. 1 (Fig. 9), while a central spindle, 30, passing through the sleeve, carries cam No. 2 (Fig. 9). The lever is connected by a link, 31, Figs. 1, 3 and 9, to the fuel pump controlling shaft, 27, Figs. 1 to 3, the cam No. 1 opens one of the two relief valves, 32, Fig. 8, and the cam No. 2 opens one of the two high pressure air valves, 33, Fig. 7. The

air valves are directly connected with the compressed air reservoirs, Figs. 12 and 14, on the one side and with mechanically operated distributing valves on the other side.

It will now be understood that when the hand wheel is turned clockwise the cam No. 2 opens the air valve on the left and admits compressed air to the ahead distributing valves, the cam No. 1 opens the relief valve on the right and places the astern distributing valves in communication with the atmosphere, while the lever brings the fuel pumps into action. The engine then starts on compressed air, but, as the fuel pumps operate immediately the engine starts, the air connection can be closed on the completion of one revolution. The latter is the function of the central spindle which carries cam No. 2. By pushing the central spindle towards the back, the air valve spindle drops off the cam and a spring plunger, 34, Fig. 9, entering a groove, 35, Fig. 9, in the central spindle, locks it in the new position. The hand wheel can now be used to regulate the speed of the engine without having any effect on the closed air valves, but whenever the wheel is placed in the stop position the central spindle is automatically released and is returned by a spring, 36, Fig. 9, to its original position in readiness for a fresh start in either direction. A start in the astern direction is effected by turning the hand wheel anti-clockwise, and thus placing the astern distributing valves in communication with the compressed air reservoirs and opening the ahead distributing valves to the atmosphere. Moving the hand wheel in either direction from the stop position brings the fuel pumps into action, and it is noteworthy that the driver's attention is confined to two simple operations, viz.: turning the hand wheel in the proper direction and pushing the central spindle when the engine has started. The air distributing valves, 37, Fig. 3, are actuated by the eccentrics provided for operating the water and fuel pumps, but are brought into operation only when compressed air is admitted to them, and consequently there is no wear and tear of the reversing mechanism while the engine is running. It is an admirable feature of this gear that no part of it is in motion except for a few seconds during each start or reverse of the engine, and it is therefore an easy matter to withdraw valves and other parts for examination or overhaul while the engine is at work.

Two of the engine cylinders are fitted with spring-loaded, non-return valves, 38, Fig. 1, through which the air reservoirs can be charged while the engine is running. A sufficient supply can be maintained in this way for all ordinary purposes, but an independent power-driven air compressor is supplied to meet the requirements of excessive maneuvering and to renew the supply should it be lost from any cause.

In the case of a 160 brake horsepower "Beardmore" engine installed in a typical British coaster, 75 feet long between perpendiculars, 18 feet beam, and 8 feet 6 inches draft, the weight of the complete installation, including fuel tanks, floor plates, pipes and connections, is 14 tons, and the engine-room bulkheads are 15 feet apart.

Development of Machinery in the United States Navy During the Past Ten Years*

Oil Fuel Adopted Exclusively on First Line Ships—Performance of Oklahoma Class Battleships—Advantages of Electric Drive

BY REAR-ADMIRAL C. W. DYSON, U. S. NAVY

As the developments of battleship machinery for the next two programmes were intimately connected, these two programmes will be discussed together, so far as main propelling engines and provision for cruising economy are concerned.

Taking up another very important change at first we will turn to the question of fuel. Experience with oil fuel on the destroyers having been so highly satisfactory, after thoroughly going over the question the Navy Department decided to fit the future vessels of the first line to burn oil fuel exclusively. The reasons governing this decision are:

1. Ease in regulating steam supply.
2. Less wear and tear on the boilers.
3. Increased boiler efficiency.
4. Maintenance of boiler efficiency.
5. Decreased complement of men.
6. Less manual labor required in operation and maintenance.
7. Greater regularity in steam pressures.
8. Less hull deterioration from corrosion.
9. Greater ease and less interference with routine of ship, in and while refueling.
10. Decrease in fuel weight for given cruising radius.
11. Decrease in total bunker capacity.
12. Ability to use otherwise waste spaces for carrying fuel.
13. Ease with which fuel can be delivered to the boilers.

In opposition to these advantages there are only two disadvantages:

1. Greater cost of fuel, due to possible limited supply to meet all demands, commercial as well as naval.
2. Less general distribution of oil over the globe, necessitating the transportation of fuel to distant points where oil fuel may not be available.

The advantages to be gained far outweighing the disadvantages, the step was taken and oil fuel was adopted. Other nations have claimed the honor of having led in this path, but their claims are not justified. Our *Oklahoma* and *Nevada* were the first sea-going battleships ever designed for the use of oil as the sole fuel.

When this determination was made it was determined to specify boilers of the large tube express type that is, generally similar in design to destroyer boilers except the diameter of the tubes, which was increased from 1⅛ inches and 1¼ inches up to 1⅝ inches, as the Babcock & Wilcox boiler was designed, and which had been practically adopted as the standard battleship boiler, was not considered suitable for oil fuel work on account of the low angle of the tubes, which was only fifteen degrees from the horizontal, and on account of the metallic side water walls of the furnace.

* Reprint from the Journal of the American Society of Naval Engineers, continued from January, 1918, issue.

Having so decided, superheaters, while very desirable, were omitted, as experience has demonstrated that superheaters fitted in uptakes outside the boiler lack durability, their deterioration being much more rapid than that of the boiler.

Babcock & Wilcox Boiler Redesigned

The *Nevada* was built with this type of boiler, the Yarrow. The Babcock & Wilcox Company had, however, in the meantime given way to the wishes of the Bureau of Steam Engineering and had redesigned their boiler, replacing the water walls of the furnace with fire brick, increasing the angle of the two lower rows of tubes next the furnace, which were 2 inches in place of one row of 4-inch tubes, and which absorb the maximum amount of heat, to 20 degrees, while the remainder of the tubes were angled at 18 degrees. In addition, the boilers were fitted with downcomer pipes from the ends of the steam drums to the outer ends of the front cross boxes.

After these changes in design were made the Bureau felt assured of the success of the new boiler, and when the contractors for the *Oklahoma* proposed its installation in that vessel, favorable action was recommended to the Navy Department and the new type was installed.

During the preceding few months a plant for testing out boilers under oil fuel, for experimenting in oil fuel burning and for instructing men in the art of oil fuel burning, had been erected at the Navy Yard, Philadelphia. In this plant had originally been installed two boilers, Normand and Yarrow, of the large tube battleship type, and the first boiler of the *Oklahoma* type to be completed was purchased and installed in the plant. Comparative tests of the three boilers showed that the Babcock & Wilcox possessed a marked superiority in economy over the Yarrow, while the Yarrow was somewhat superior to the Normand.

Propelling Machinery of Oklahoma Class Battleships

The propelling machinery shown and specified was of the reciprocating engine type, fitted with forced lubrication and with two condensers per engine, one located at each end of the engine with a short, large diameter connection to the adjacent low pressure cylinder. These exhaust connections were fitted with accordion joints to care for expansion and vibration, and with gate valves by which the condenser could be cut off from its cylinder. In each L. P. receiver pipe was fitted a gate valve by which, in case of a badly leaking condenser or disarrangement of a L. P. cylinder, the cylinder involved should be cut out and the engine run as a three-cylinder triple, at reduced power. Each condenser had its own air pump and circulating pump. The air pump channel ways were all cross-connected in order that any number of the pumps could be used as desired. The two circulating pumps at the same engine ends had their suctions cross-connected. This enabled suction to be taken from either side of the ship in case of grounding. It also permitted suction of one pump to be taken through the condenser on the opposite side of the vessel, using the outboard delivery of that condenser as a main injection. In fact, every possible measure was taken to render the ship immune from breakdown.

While the designs were being prepared the Fore River Shipbuilding Company appeared on the scene with a proposed layout of turbine machinery consisting of a high and a low pressure turbine on each shaft, there being two shafts, and with the revolutions decreased from the 280 of the *North Dakota* to 200. An estimate of this proposed installation being prepared by the Bureau, it was found that it would require approximately the same shaft horsepower for the different speeds as the indicated horsepower for the same speeds of the reciprocating engine ship. This was a large reduction in power as compared with previous turbine-driven vessels, and the Bureau recommended that this plan be accepted, requiring, however, that additional changes be made to give better economy at cruising speeds and securing the guarantees by abnormally heavy penalties. The means provided to obtain this economy a cross-connection was to be provided between the exhaust pipes of the high pressure turbines on the two shafts in order that, at reduced powers, steam could be taken in the high pressure turbine on one shaft and exhausted into the L. P. turbine on the other, the other two turbines running in vacua. This doubled the amount of steam flow through each active turbine and so held up the economy. This fitting was never installed, however, as a much better scheme was developed with the next year's battleships.

The contracts as carried out provided one battleship, the *Oklahoma,* with reciprocating engines and Babcock & Wilcox boilers, and one battleship, the *Nevada,* with compound Curtis turbines on two shafts, with turbines and reduction gear for cruising. Neither vessel was fitted with superheaters.

Change in Cruising Engines

The change in the cruising apparatus came about through action taken on the design of propelling engines for the battleships next appropriated for, the *Pennsylvania* and *Arizona.*

During the preparation of plans for these two vessels, the Bureau of Steam Engineering was approached and inquiries made as to whether turbine installations would be considered. The inquirers were told that if turbine installations promising an equal or nearly as low a fuel expenditure as the reciprocating engines shown in the Department plans, preference would be given to the turbine installation.

To meet this requirement the Curtis turbine advocates presented a plan having four shafts with high pressure turbines on two inboard shafts and low pressure turbines on the two outboard shafts. The Bureau informed them that if cruising turbines with reduction gear were fitted to the low pressure shafts, exhausting to the main H. P. turbines, the installation would be approved. This change was made and one vessel, the *Pennsylvania,* was fitted with Curtis turbines designed for 220 revolutions per minute, and the other vessel, the *Arizona,* with Parsons turbines of 240 revolutions per minute, both of them being fitted with cruising turbines and reduction gear for economy at low speeds. These vessels were the first battleships ever laid down by any nation with this arrangement for cruising economy. Before the *Nevada* was completed the contractors, evidently fearing that the guaranteed cruising economies could not be realized, proposed to the Department that the means for obtaining this economy originally proposed be abandoned and that cruising turbines and reduction gear installed on each shaft forward of the main turbines be substituted. This change was approved and the machinery so built. The *Nevada's* turbines marked a further advance for this type in that the old form of disk diaphragms between stages was abandoned; diaphragms split on the horizontal diameter being fitted. The turbines as fitted on the *Pennsylvania* also marked a still further advance, the high pressure turbines in this vessel being of the so-called "reverse flow" type, which means that after the steam had passed partially through the turbine, a portion of it was by-passed to the after end of the turbine and flowed forward, thus reducing the

steam thrust and also, if so desired in the design, decreasing the lengths of the blades.

The economy results obtained with the three vessels which have been tried up to date, the *Nevada, Oklahoma,* and *Pennsylvania,* have been very satisfactory and all expectations have been met. The low power results with the last named ship may even be classed as remarkable.

Economy of Oklahoma Class

Taking the *Oklahoma's* fuel consumptions as 100 percent, the fuel expenditures were as the following percentages:

Speeds	10	15	19	20.5
Oklahoma, percent	100.	100.	100.	100.
Nevada, percent	88.9	88.6	99.8	101.2
Pennsylvania, percent	91.5	103.6	101.4	101.6

This shows that the *Pennsylvania,* while over 3,000 tons heavier than the *Oklahoma* and *Nevada,* on the trials consumed very little more fuel than the reciprocating engined ship.

These results marked the passing of the reciprocating engine for battleship propulsion, and the succeeding two vessels, the *Mississippi* and *Idaho,* were practically duplications of the machinery of the *Pennsylvania* and *Arizona.*

Destroyer Tenders

During this same period the Department contracted for and there were constructed a destroyer tender, the *Melville,* fitted with Westinghouse reduction gear, consisting of H. P. and L. P. turbines driving two pinion shafts with pinions meshing into a gear wheel on the single main shaft, and a submarine tender, the *Bushnell,* with Parsons reduction gear, similarly fitted. The latter vessel had, however, one innovation, and that was in the means taken to drive the generators for providing current to charge the submarine batteries. These generators were two in number, one located directly forward and in line with each turbine shaft, to which they were attached by means of loose couplings, similar couplings also being fitted between the turbines and reduction gears. By this means both the main turbines could be used for driving the generators in port, while when under way either turbine could be used for driving the main propelling shaft while the other operated one of the generators, or both generators could be cut out and both turbines used to propel the vessel. During this same period plans were purchased for Diesel engines of 2,500 shaft horsepower, and work started on the construction of two of these engines for the fuel ship *Maumee.* These engines have been completed and the vessel is now in service. The *Maumee's* engines represent the maximum power installed in any one ship up to the present time. All three of the above installations have been satisfactory in operation and undoubtedly mark the passing of the reciprocating steam engine from the field of auxiliary vessels.

The forced draft blowers on the *Oklahoma* and *Nevada* are driven by electric motors, but trials have demonstrated that there is not sufficiently close regulation of air supply for efficient oil burning with this type of drive, having its speed regulation stepped. These blowers are to be replaced with steam turbine-driven ones similar to those on the later vessels.

Electric Propulsion

The next advance in propulsion of capital ships occurred when the Department decided to fit the *New Mexico* with electric propelling machinery. This decision was the result of the unqualified success of this type of machinery on the *Jupiter.* This decision has since been adhered to and there are at present seven battleships and four battle cruisers building with such machinery.

The advantages of electric machinery for such classes of vessels are:

1. Greatly increased torpedo protection for ships.
2. Greater flexibility in machinery arrangement.
3. Better and wider separation of important units.
4. Minimum lengths and diameters of steam pipes.
5. Fewer bulkheads pierced by steam and feed piping.
6. Reduced heating of vessel from steam pipes.
7. Better centralization of power.
8. Reduced engine room complement.
9. Elimination of danger from fractures of piping due to shells striking protective deck.
10. Greater ease in control.
11. Greater flexibility in power distribution.
12. Better maintenance of economy through a wide range of powers.
13. No metallic contact between rotor and stator of motor.
14. Eliminating all dangers of disarrangement due to shaft vibration when the helm is put hard over.
15. Maximum reduction in length of shafting.
16. Increased backing power.

In opposition to these claims can only be advanced one, that of greater weight. This can be discounted on the heavy ships where protection is of vital importance. On the light, fast vessels, such as destroyers and scouts, where no protection exists, everything is sacrificed for speed, and for such vessels the mechanical reduction gear stands pre-eminent to-day.

Conclusion

In the course of this paper I have taken you through power development from 16,500 indicated horsepower to 60,000 shaft horsepower for battleships, from 25,000 indicated horsepower for armored cruisers to 180,000 for battle cruisers, and from 7,500 indicated horsepower to 28,000 shaft horsepower for destroyers. Also I have shown you the reciprocating engine reaching its maximum efficiency and disappear, to be replaced by the turbine drive with and without cruising units. This again, when highly successful, has bowed its head and moved aside that the straight mechanical or electrical reduction gear might take its place. The end has not yet been reached, but probably changes from now on will be slow and no decidedly new type will usurp the places of those now in use for years to come. The future is in the hands of the young men of the Service, and every confidence is felt that they will not lag behind in taking their share of the burden in the development of the marine machinery of the future.

American Foreign Trade in September.—American exports in September totaled $456,201,567 (£93,500,000), according to a statement just issued by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce. This is a decrease of approximately $34,000,000 (£7,000,000) compared with August, but a gain of $80,000,000 (£16,400,000) as compared with July. For the nine months ended with September the total exports were $4,607,817,178 (£945,000,000), a gain of $657,000,000 (£135,000,000) over the similar period in 1916.

Imports in September also fell off, the total being $236,196,898 (£48,600,000), as compared with $270,509,379 (£55,500,000) in August. The total imports for the nine months ended with September were $2,282,794,503 (£470,000,000), a gain of $450,000,000 (£92,400,000) over the corresponding nine months in 1916.

Transportation Efficiency for the War

What New Orleans Has Accomplished and What New York Can Learn From It—Development of Terminal Facilities

BY E. AMBERG

CONGESTION of traffic is a serious handicap at all times, but at present it is particularly vital to our successful prosecution of the war. Owing to the vast growth of business caused largely by the European war, the freight traffic on American railroads and at steamship terminals has been greatly increased, with the result that facilities for handling past quantities of freight naturally are inadequate for handling the present increased amount. Terminal reorganization and more freight handling facilities are the propelling factors in solving the present problem. Not ten years ago James J. Hill predicted the breakdown of our railroads unless terminals were revolutionized.

New York, the first port of the United States, acts as a depot of distribution for the products of numerous industries of America. Fifty percent of the foreign trade of the United States passes through the port of New York. Thus delays in delivering freight and consequent excessive costs in New York not only affect the port locally, but influence the industry and commerce of the whole country as well.

The people of the South have long been reputed as a dreaming, easy-going lot, but visit the city of New Orleans now and see for yourself what strides industry has taken there and what a far-seeing people guard its commercial interests. Preparedness has been their watchword. The course of events pointed the way to the expansion of foreign trade, and New Orleans began to develop her port equipment with that end in view long before the expansion was here.

New Orleans has a marvelous physical situation—only 110 miles from the Gulf of Mexico, with accessibility to Eastern commerce, with an open door to the trade of the West through the Panama Canal, and with the Mississippi River encircling the city for 41½ miles, providing a trade route of least resistance.

But where is New York's physical lack? It has its own harbor leading to the Atlantic, and a water frontage of 928 miles, with the Hudson River on one side and the East River on the other.

However, development does not rest alone on physical structure; it depends also upon financial and administrative features. New Orleans has been wise in preserving her water front as a public heritage (as far back as the treaty of Louisiana) and by creating and operating a municipally owned switching Belt Line.

New Orleans Water Front a Public Heritage

Only a small fraction of her water front (less than 3 miles of the 41) is controlled by the railroads, and this water front is subject to expropriation by the State at any time. The public docks are governed and operated by a State board with entire control of the water front and with the broad power "to do any reasonable and practical thing to increase the efficiency and economy of the port's facilities." The Dock Board handles 83 percent of the port's business.

Prior to the development of the docks the city leased the wharves to private corporations, but, on account of the poor structure of the wharves, insufficient machinery for handling freight and too high assessment of charges, this proved unsuccessful as a public utility.

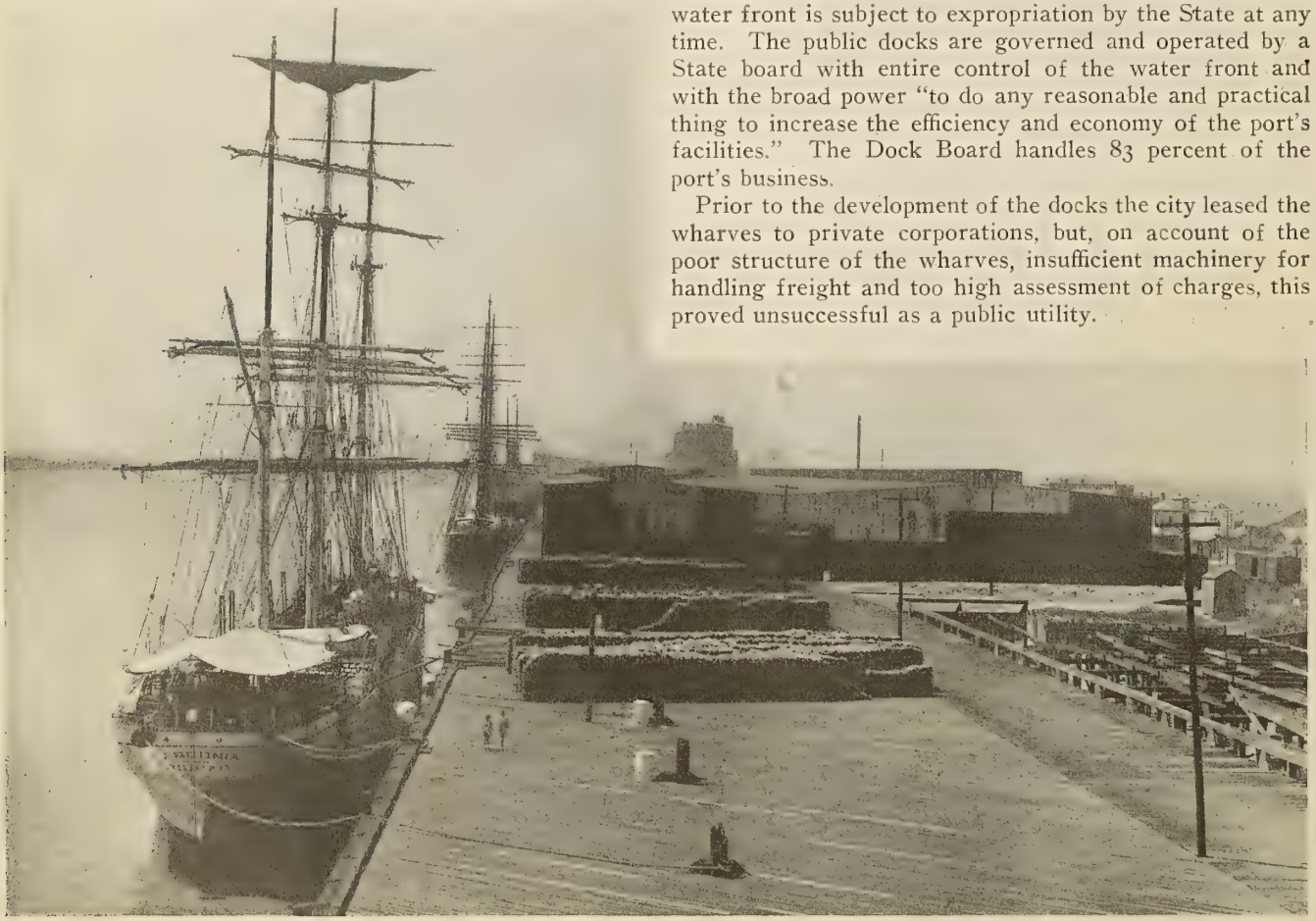


Fig. 1.—Typical Landing at New Orleans Water Front

Fig. 2.—Barges and Stern-Wheel Steamboats, Characteristic River Craft at New Orleans

The Dock Board has constructed permanent wharves of creosoted material and protected them by steel sheds. It has, furthermore, devoted itself to developing mechanical devices for expediting the movement of freight. Bananas are an important import of New Orleans. Formerly bunches were conveyed from the holds of ships by tackles and passed along by hand to the cars. Now the banana conveyor is used. It consists of a moving canvas belt drawn over iron frame-work, and—traveling on rails on the docks—can reach right into the hold of any ship. Each conveyor unloads about 2,500 bunches an hour, the average boat taking three conveyors (very often four), making a minimum of 7,500 bunches an hour and a maximum of 10,000 per hour. With former methods the maximum per hatch was 800 bunches per hour, 2,400 on a three-hatch vessel and 3,200 as a maximum.

The Dock Board's chief accomplishments, however, are a tremendous cotton warehouse and a huge grain elevator, the first costing $3,500,000 (£717,500) to construct, and the latter $2,000,000 (£410,000), both of which were financed through bond issues granted by the State. The board has an appreciable surplus from its 1917 revenues,

Fig. 3.—Transferring Freight from Warehouse to Hold of Sea-Going Vessel

with which it plans to build a large commodity warehouse. The warehouse and the elevator are not entirely completed, but handle a large amount of consigned freight at present. These two public facilities are adjacent, cover 100 acres of ground together, and will operate in conjunction with each other in such a manner as to permit ships to be loaded with cotton and grain simultaneously.

Both buildings are constructed of reinforced concrete, and the cotton warehouse is built in units to prevent the spread of fire, thus producing a considerable reduction in the fire insurance rate. The present charge for insuring grain at the port of New Orleans is 15 cents (0/7½) per $100 (£20.5), as opposed to a former charge of $1.65 (6/10½) per $100 (£20.5), and cotton insures for 0.31 percent per bale, while the former rate was as high as 1¼ percent per bale.

The cotton warehouse affords shipside storage, carrying surplus supplies of cotton subject to instant use of all consuming markets. Cotton designated for consumers in America and passing to foreign ports involves the charge of conveying to Europe and that of carrying it back again. Cotton held in storage at New Orleans can, whenever needed, pass to consumers in America or Europe under economic conditions.

The warehouse is a two-story building, all incoming freight is handled on ground floor and all outgoing freight on the upper floor. All phases of handling and storing cotton are provided for. The press room is provided with high density presses and faces north for the purpose of supplying the best light for testing samples. Overhead traveling cranes running in any direction pick up two bales at a time, involve the labor of only two men and save a great deal of time in piling. Electric tractors convey the bales on runways that encircle the building to any part of it. The bale-puller is another efficient device. It connects with the crane and by means of two steel arms which run in over the designated bale to keep off the strain of the rest of the pile, and by manipulation of a steel hook it neatly pulls out any individual bale of cotton without disturbing the rest of the pile at all.

The present capacity of the warehouse is 209,000 bales, and it will hold 500,000 when it is finished.

The grain elevator is 208 feet high. It holds 1,200,000 bushels of grain, and the annex which is under construction will hold 1,600,000 more. Grain is taken from the cars at the rate of 200,000 bushels per hour, is carried into elevators, conveyed by them to the top of the building, where it is weighed, then dropped into huge bins and sent from thence through chutes and innumerable belts to the holds of ships as fast as 100,000 bushels per hour. The equipment for taking grain from barges consists of great pneumatic suction pipes.

The entire elevator is run automatically by a system of light and gongs, thus resulting in minimum labor usage, 35 to 40 men constituting the entire working crew.

The Public Belt Railroad has been another fundamental factor in the development of New Orleans as a world port. This Belt Line is a publicly owned and operated facility. It provides non-discriminatory switching service to 11 trunk lines entering the city and 70 industries, manufactories and warehouses. It has the sole switching rights of New Orleans, and this, together with the fact that the line is municipally owned, makes a low, uniform switching cost easily understandable.

The charge for the switching service is $2 (8/8) per car, as opposed to a former charge of from $8 (1/13/8) to $13 (2/14/4) per car previous to the construction of the Public Belt in New Orleans. In the city of New York the costs to the railroads alone for delivering freight from New Jersey Meadows to New York City is $1.80 (7/6) per ton, and $25 (£5.1) to deliver a 20-ton car.

The services of the Public Belt are free to all users of the line in that all railroads absorb the switching charges on competitive business which exceeds 90 percent of the business handled by the Belt Line.

There is no doubt of the necessity for expediting the freight movement of the port of New York. New Orleans has already developed her port along efficient and economic lines; her facilities are available impartially for all shippers and receivers, and counteract the competition of rival railroads. This successfully worked out scheme points the way for New York; and when once the benefits are reaped from terminal improvements they will not be considered as merely temporary structures for war-time expediency, but will prove their value to the industrial and commercial future of the United States.

The Great Floating Cranes at Panama

Main Particulars of 250-Ton Floating Cranes Built in Germany for the Panama Canal

BY FRANK A. STANLEY

THE gigantic floating cranes, *Hercules* and *Ajax*, constructed for the Panama Canal, constitute two of the most important pieces of equipment in the great array of mechanical apparatus to be seen on the Canal Zone. They were built as part of the necessary equipment of the completed canal for handling gates of locks and docks, for handling unusually heavy pieces of freight, big guns and other material, and for service in connection with the repairing of ships, wrecking, etc. They are each capable of lifting loads up to 250 tons.

The two cranes were built in Germany and towed across the ocean to the canal; that is, the pontoons, with their fixed towers, power plants, and revolving superstructure, were towed bodily to the Isthmus, and the jib and certain other elements which had been shipped in "knock down" condition, were then erected in place.

Dimensions and Capacities

A general view of the *Hercules* (the cranes are alike in all respects) is shown in Fig. 2. The appearance of the crane in the canal, surrounded by other floating equipment, is well brought out by Fig. 1. Some general dimensions of importance, as showing the great size of the crane, are given in the following: The pontoon is approximately 150 feet long by 89 in breadth, while the top of the jib when in its innermost position is 206 feet above the pontoon. The counterweight under the operator's cab weighs 150 tons. There is another counterweight of 450

Fig. 1.—The *Hercules* in Operation at Culebra Cut

The crane, with a capacity for lifting loads up to 250 tons, is mounted on a pontoon approximately 150 feet long by 89 feet beam, while the top of the jib when in its innermost position is 206 feet above the pontoon. Three counterweights are fitted, one of 450 tons in the after end of the pontoon; a second of 150 tons under the operator's cab, and a third on the crosshead. All motions and hoists are operated by means of electric motors supplied with current generated by a steam plant, situated below decks in the after portion of the pontoon.

Fig. 2.—General View of Floating Crane *Hercules*, Showing the Two Hoists. The Main Hoist Is Designed for 250-Ton Loads and the Auxiliary Hoist for 15-Ton Loads

Fig. 3.—The *Hercules* and *Ajax* Dry-Docked in Gatun Lock of Panama Canal. The Cranes Occupy Only One-Third the Length of Lock Chamber

tons in the after end of the pontoon, and a third on the cross head.

All motions and hoists are by means of electric motors which operate the shafts, gears and drums, 220-volt current being generated by a steam plant situated below decks in the after portion of the pontoon. The pontoon itself is not self-propelling.

Near the center of the pontoon the deck is made extra strong. This portion, extending over an area 20 by 60 feet, is designed to carry loads up to 2,000 pounds per square foot and is intended to receive deck loads of 300 tons, so that when necessary the crane can carry very heavy loads on its deck and thus dispense with the use of barges.

Block and Hoist Details

There are two blocks on the main hoist, each of which is carried in ten parts of 2-inch steel cable. The block and guide sheaves are 63 inches in diameter—that is, over 5 feet across. The blocks measure over all 9 feet in height by 6 feet in width, and are built up of steel plates and angles. To one unaccustomed to anything but the very heaviest of engineering work these blocks, which actually form but a small detail of the giant crane, are most interesting objects, and the same may be said of the triangular "hook" which is used with an equalizing bar when the two main hoists are operated together, this hook having a capacity of 250 tons.

The auxiliary hoist, which is equipped with a double barbed hook, has a rated capacity of 15 tons and the hook is, of course, designed for that load with a reasonable excess under test conditions.

The Cranes in Dry Dock

A striking view of the two cranes drydocked in the upper chamber of the east flight of locks at Gatun is shown in Fig. 3. This engraving brings to attention at once the immense proportions of the *Hercules* and *Ajax* and the capacity of the locks themselves, which enable the two cranes to be so readily docked. Bulky as they are, the cranes occupy less than one-fourth the space available in the lock chamber, for the latter has a length of 1,000 feet and a breadth of 110 feet, so that the two pontoons, with their combined lengths totaling over 300 feet require for docking less than one-third the length of the lock chamber and on either side of the pontoons is left a 10-foot clearance space between cranes and walls.

Watertight Doors*

System of Doors Giving Communication to Compartments Without Impairing Watertightness

BY ENG.-LIEUT. I. TORO †

THE introduction of watertight doors for ships was a necessity which arose when watertight bulkheads came to be fitted, in order to give ready access to compartments which contained the machinery, or other compartments to which it was deemed desirable to get access periodically for inspection, and yet have efficient means readily available to isolate these in emergency.

The necessity demanded the invention of a system which could be readily available when the moment arrived to close the doors. Several plans have been invented for the purpose, and yet there appears room for more—hence that which is now submitted for discussion.

The object of this system of watertight doors is to allow of easy communication from one compartment to another, also to provide means of escape from one compartment to an adjoining compartment without allowing the watertightness of the bulkhead to be impaired.

Construction of Air-Tight Chamber

In this system an opening is cut in the bulkhead, and to this opening is fitted, in a water- and air-tight manner, a chamber or cell of rectangular or other suitable shape; this cell is formed by two rigid cast steel frames of the required dimensions, to enable one or more men to move about in the cell. This chamber has two openings, one at each side, through which men can pass, and each of these openings is fitted with a sliding door (*EE*) adapted to slide in ways to and from the seat, so that, when open, there is a clear entrance into the chamber, or, when closed, a wedge-shaped edge on the door enters between correspondingly shaped faces or into a recess in the seat or sill of the opening, thus forming a watertight joint to prevent leakage and render the door self-packing. In the diagrammatic sketch reproduced these doors are operated hydraulically, but they could also be worked pneumatically, electrically or otherwise, in such a way that under no circumstances whatever can both be opened at the same time, one door remaining open when the other is closed, and *vice versa*, or both remaining closed.

Operating Gear

As the gear for operating both doors is similar, in the following description we shall refer to one door only, except where the gear of one door interferes with that of the other. A convenient method of operating the doors is by means of a rack or racks on each door operated by pinions keyed on a shaft. In the case of hydraulic power being used, a hydraulic cylinder *A* is provided fitted with a piston whose piston rod has a rack *B* gearing with a pinion *C* keyed on a shaft which has another pinion *D* gearing with a rack on the door *E*, so that by admitting pressure to one side of the piston in the cylinder and putting the other side to exhaust, the door is opened or shut according to the direction in which the pressure acts. In the sketch, pressure to open the door should be admitted at the top end of the cylinder.

Controlling Valves

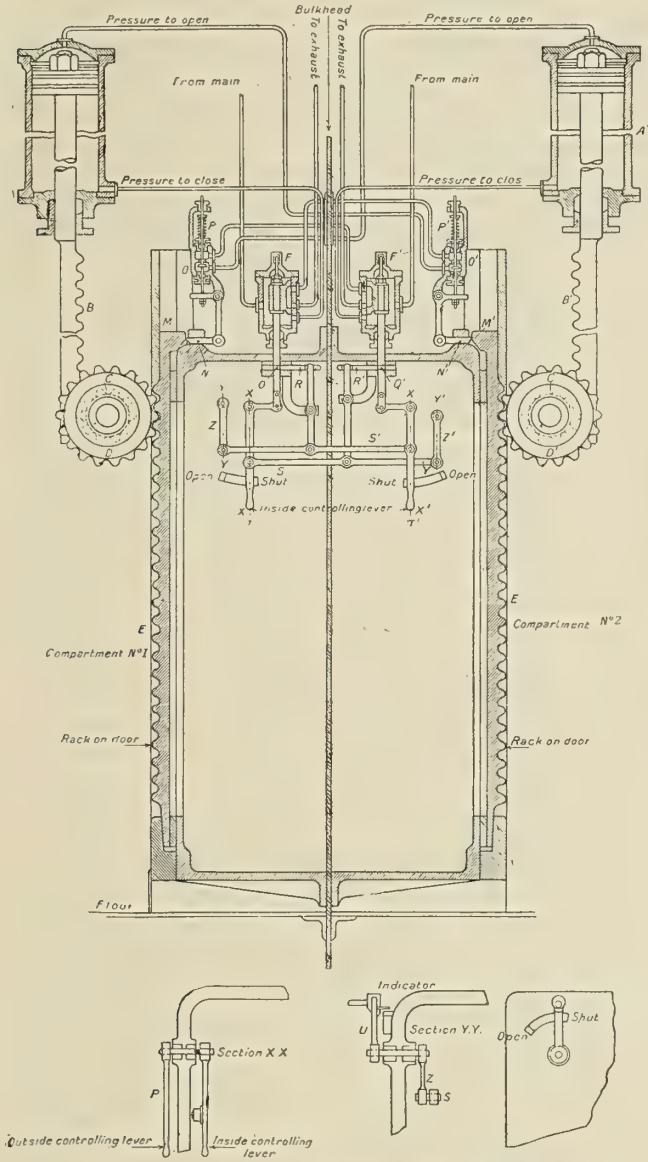
The controlling valve for the hydraulic cylinders can be operated from the inside of the chamber or cell by means of a pair of hand levers, or from the outside of the chamber by similar levers, the said levers being adapted to control ordinarily the respective doors. The working lever *T* is of the bell crank type, and is connected to the lower end of the spindle of the controlling valve *F*. The doors are so arranged that one must be completely closed before the other can be opened. To fulfil this condition, certain

* Paper read before the Institute of Marine Engineers, London, September, 1917.

† Chilian Navy.

appliances, which vary according to the gear used to operate the doors, are provided; in the case of hydraulically operated doors, an intercepting valve *O* in connection with each door is provided, this valve being worked by the door in such a manner that when one door is opened, fluid pressure to open the other door cannot reach the hydraulic cylinder.

The intercepting valve *O* may, if desired, be fitted in the top of the chamber, its spindle being connected to a bell crank lever *N*, one of whose arms is operated by a cam *M* fitted on the top of the door in the rear, and so



Diagrammatic Sketch of Door and Controlling Mechanism

arranged that only when the door is perfectly closed the cam *M* would move the spindle of the valve *O* to allow a free passage between the controlling valve and the opening end of the cylinder actuating the other door. The chambers of the intercepting valve *O* are connected respectively by pipes with the hydraulic cylinder that operates the other door, and with a port in the chest of the controlling valve that operates the said hydraulic cylinder, so that the pressure fluid, on being admitted by the controlling valves, passes through the pipes by way of the intercepting valve of one door to the hydraulic cylinder of the other door. The chambers of the intercepting valve of the opposite door are similarly connected, so that the opening of one door keeps the other closed, and *vice versa*. If, therefore, one of the doors be opened, the act of opening will release its intercepting valve spindle, so that such intercepting valve closes by the pressure of the spring *P* and cuts off any admission of pressure fluid into the hydraulic cylinder of the other door. It will be seen, therefore, that if one door be open and the other closed, the operation of the lever to open the closed door would have no effect, because the intercepting valve would be closed and pressure fluid could not reach the hydraulic cylinder to open that door. When both doors are closed, then either lever can be operated to open one door or the other.

Locking Devices

To prevent both doors being opened simultaneously, there are certain locking devices provided which consist of locking bolts *RR*, coupled either directly or through the medium of rocking arms and levers *SS* with the opposite hand levers, such locking bolts being adapted to lock the valve spindles under certain conditions—that is to say, when both doors are closed, the locking bolts are in the "off" position, but when one or other of the controlling levers is operated, the locking bolt connected therewith is shot forward into slot *Q* or *Q* cut in the valve spindle of the other controlling valve so as to lock it and prevent it being operated. It will be seen that the locking bolts provide also a device which prevents in any case one door being opened while the other is open, as the slots *QQ* cut in the spindles are only exactly in front of the said bolts *RR* when the levers of the controlling valves are in the shut position—that is to say, when the doors are closed. When one door is open the slot of the controlling valve spindle is moved from its original position, the passage being intercepted by the solid part of the spindle, so that the lever of the other door cannot be moved from the closed or shut position, as the locking bolt connected to it has its travel barred by the spindle of the other controlling valve.

Should one or both of the intercepting valves *OO* not work as intended, this mechanical device provides a further means of preventing both doors being opened at the same time. Moreover, if desired, the use of the intercepting valves could be dispensed with and only the locking bolts used. This one door must always remain shut, and in no case could there be a through passage from one compartment on one side of the bulkhead, or partition, to the other side thereof.

Operation of the System

The working of this system of doors in order to get from one compartment to another is as follows: The door at one side of the chamber or cell is opened first by means of the outside controlling lever to allow the man or men to gain admittance to the cell. This door is then closed by one of the controlling levers inside the cell. When this is properly closed, but not before, the opposite door can be opened by the other controlling lever, enabling the men to obtain admission into the other compartment. In no case can there be a through passage from one compartment to the other, as one door must always remain shut.

In ordinary circumstances each door may be controlled from its respective side, but as it may happen that the panic-stricken men rushing from a compartment where there is danger to the adjoining compartment might easily forget to shut the door of the safe compartment, thus preventing other people from escaping, an emergency arrangement is applied which permits of the controlling of the doors from the opposite compartment; with refer-

ence to the sketch, the lever *S*, besides being connected to the rocking lever that works the locking bolt *R*, is connected also to an arm *Z* pivoted on a shaft which is fitted in a watertight and airtight manner through the side of the chamber; in the outside end this shaft has keyed to it an arm *U*, fitted with a handle and also with an index which works between the positions *open* and *shut*. In this manner the possibility of leaving men locked in a compartment is therefore prevented, as by means of the arm *U* the controlling valve of the opposite door can be worked, and therefore this door can be closed to allow the opening of the other door. If necessary, a device may be applied to give a signal of the completion of the operation of passing from one compartment to the other.

The controlling valves could be of the ordinary type, but the interlocking device might, I think, be applied to some of the patented valves that can be operated from the bridge. In my system there is, however, no need of this control from the bridge, as under no circumstances whatever is there a through passage from one compartment to another; in fact, it may be said, as far as the efficiency of a watertight sliding door permits, that the bulkhead is intact.

As mentioned before, the sketch given is only a diagrammatic one, and the positions of the different parts may be altered to suit circumstances; for instance, in actual practice it will be more convenient to place the controlling valves in the sides of the chamber; in such a case the outside controlling lever would be of the bell crank type, and would be connected to the spindle of the valve; the inside controlling lever would also be of the bell crank type, and it would be connected to a cylindrical bar containing the slot for the locking bolts; this slot would be cut in such a position that it would be just in front of the locking bolts only when the controlling valve was in the shut position. The chamber or cell is provided with means for ventilation, and also with lighting arrangements. This system of doors could also be applied when using electrical or mechanical power, but naturally the gear would be somewhat different in construction, though similar in principle. The invention may also be applied as an air-lock for submarine vessels and for diving purposes, etc.

In connection with the use of doors in the bulkheads of warships, the naval authorities do not allow their application, although they recognize the difficulties under which the engineering force has to work to obtain full efficiency from machinery placed in isolated places, not always run by careful hands, but the naval authorities consider that where there is a *door* in a bulkhead, there is a *hole*. All this may be applied to single doors, as in the moment of danger a plank of wood, a shovel or any other article might be left at the door, which would prevent it from closing, but with my system such a thing is impossible, as there must always be one door closed, and therefore the bulkheads is always watertight. In merchant ships, doors are allowed in bulkheads; with this system of double doors which are *fool-proof*, the safety of such ships would be considerably increased, as, for reasons already stated, the bulkheads would always be watertight, notwithstanding that there would be easy means of communication between the different compartments. I think that this system of doors is *fool-proof* and able to fulfil the demand of always maintaining the watertightness of the compartment, and at the same time permitting safety of entrance to or exit from the compartments.

Tank Steamer Construction*

Recent Growth of Tank Steamer Fleet—Striking Features of Design—Standardization

BY ROBERT W. MORRELL, M. E.

THE growth of the American tank steamer fleet since the beginning of the European War has been so remarkable, and the tank steamers now represent such a large and important part of our merchant marine, that the construction of these vessels cannot fail to be a subject of interest in maritime circles.

At the end of the year 1914 the tank steamers under American registry numbered about 80 (exclusive of barges), of 278,837 gross tons and approximately 416,000 tons deadweight, which at the time represented only about 10 percent of the total steel tonnage of the United States, excluding the Great Lakes and sailing vessels.

At that time shipbuilding in this country was almost at a standstill and the outlook was very gloomy. So complete was the cessation of activity in the shipyards that this period of depression may be said to represent the line of demarcation between the old shipbuilding era and the new.

Early in 1915 shipbuilding took on a new lease of life, and it is interesting to note that it was the construction of tank steamers which started most of the yards on their new road to prosperity. It was the need for oil carriers which rescued the shipbuilding industry and revived it.

Since the beginning of 1915 there have been built in this country 57 tankers (exclusive of barges), of 371,900 gross tons and 519,200 tons deadweight, thus more than doubling the American tank steamer tonnage. It will also be noted that the average tonnage of the individual vessels shows a great increase over that of the vessels previously built.

In addition to the extensive building program carried on, a marked addition to the American tanker fleet was made under the provisions of the Panama Canal Act of August 18, 1914, by means of which 40 foreign-built tankers, aggregating over 190,000 gross tons, or 285,000 tons deadweight, have been transferred to American registry.

We therefore have the honor of displaying the American flag from the largest tank ship afloat—the German-built steamer *Jupiter*, now the *Standard*, of 10,073 gross tons and 17,000 tons deadweight. The second largest tanker is a British vessel of 15,500 tons deadweight, while the United States ranks third, having constructed a type of vessel of 15,000 deadweight. It might be mentioned that six vessels of this size have already been turned out in this country, and that four more are nearing completion.

Up to the present date we have lost six tankships

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1917.

through war causes. Two of these were German-built, three British-built and one American-built. They represent a gross tonnage of 26,537 and 38,590 tons deadweight.

The total number of American tankers now in service is therefore about 170, having a total gross tonnage of 823,200 and a total deadweight carrying capacity of 1,180,000 tons. Thus it will be seen that during the recent period of activity the number of tankships has been increased 112 percent, the gross tonnage increased 185 percent, and the total deadweight tonnage increased 185 percent. Not only is this the case, but it is also found that the tank steamer tonnage is now close to 20 percent of the total steel American tonnage (exclusive of the Lakes), as against 10 percent at the beginning of 1915, thus indicating that the greatest of the recent progress in shipbuilding has been in the construction of tankers, and that the growth of the oil industry has demanded for them a prominent part in our shipbuilding program.

Tank Steamers Building

In addition to this impressive fleet of tankers, we now have under construction in the United States a total of 64 tank vessels, representing 496,680 gross tons and 575,750 tons deadweight, marking the greatest shipbuilding activity in the history of the country. This recent construction on so large a scale could not fail to bring out interesting and instructive features deserving of comment.

The most impressive feature of the modern tanker is the size. Previous to 1915 the average deadweight was 5,200 tons, but the average deadweight of the vessels built in the United States since that time is 9,100 tons.

In 1915 the largest American tankers were the steamers *John D. Archbold* and *John D. Rockefeller,* of 11,500 tons deadweight, but we have since built ten larger vessels, the largest of which attain a deadweight of 15,000 tons. The shipowner's faith in the economy of the large tankers therefore appears to be firmly established. In fact, under certain conditions, the large vessels, trading at ports having limited depth of water and therefore obliged to load part cargoes, have been able to compete with smaller vessels whose light draft permits loading full cargo.

Development of Shelter-Deck Type

Along with the increased size came the development of the shelter-deck type of vessel. The term "shelter-decked type," as commonly used in this country in referring to tankers, applies to a vessel having three continuous steel decks, the uppermost of which is the strength deck. According to Lloyd's Register, a shelter-decked vessel is one in which the uppermost or shelter deck is a light, continuous superstructure, with one or more tonnage openings. If without tonnage openings, it is an awning-decked vessel, while if the upper scantlings are heavier it becomes a spar-decked vessel. The commonly accepted use of the term "shelter-decked vessel" in this country, however, is in reference to any vessel having a continuous weather deck, as opposed to the type having raised forecastle, bridge and poop.

The first shelter-decked tankers built in this country were the sister ships *John D. Archbold* and *John D. Rockefeller,* of 11,500 tons deadweight each. These vessels had the oil tanks carried up to the upper deck, which is the next deck below the shelter deck. The oil hatches were located on the upper deck, and gas trunks were built around the hatches and extending from upper to shelter deck, to keep the gases from permeating the 'tween-deck space.

Experience has proven these trunks a source of danger to the ships, as the heavy gases accumulate at the hatches and great caution is necessary to prevent men from being overcome when entering the tanks. Apparatus for clearing these spaces of gas has since been installed.

The next step in the development of the shelter-decked type was the carrying of the expansion trunks right up to the shelter deck. This was embodied in the *Charles Pratt* and subsequent vessels of that type with great success.

With this arrangement, the expansion trunk bulkheads extend from the second deck (or main deck or tank deck, as it is variously called) up to the shelter deck, thus making the expansion trunk two decks in height. The summer tanks are arranged outboard of the expansion trunk between the second and upper decks. The oil hatches for both main and summer tanks are located on the shelter deck, and small trunks, extending between the upper and shelter decks, are built for the summer tanks. Outboard of the expansion trunk, between the upper and shelter decks, are open 'tween-deck spaces above the summer tanks.

The principal advantages of this design over that in which the oil is not carried above the upper deck are as follows:

1. An increase of about 10 to 15 percent in the cubic capacity of the tanks is obtained, which is of great benefit when carrying light grades of oil.

2. The vessel can be trimmed when loaded with much better results, as the expansion trunk extending through two deck heights gives great scope for the desired ullages. If the vessel has a tendency to trim by the head when leaving port on account of full fuel tanks forward, this can be overcome with the present design by leaving large ullages in the forward cargo tanks and smaller ullages in the after tanks. It is also possible, as fuel is used, to maintain any desired trim by transferring the cargo. The deep trunks allow great leeway in this respect.

3. On account of the oil hatches being on the shelter deck, the danger of getting gas in the 'tween-deck space is avoided.

4. The center of gravity of the cargo is higher, making an easier ship.

5. The expansion trunk and center line bulkheads, extended up to the shelter deck, provide valuable additions to the longitudinal strength of the ship.

To offset the above, it should be noted that additional steel is required to carry the trunks to the shelter deck and that the scantlings must be increased on account of the increased head of oil. Therefore a slight increase in the hull weight is involved, and, if the vessel is to carry only heavy crude or fuel oils, the extension of the oil space above the upper deck is not advisable. This brings out the fact, which is constantly cropping up, that to design the most economical tankers they must be specialized for particular trades and used in no other trades. The point just mentioned illustrates this—if the vessel is intended to carry light oils, the oil space should be made as large as possible by extending it up to the shelter deck; but if intended to carry only heavy oil, large cubic space is not required and the oil space may terminate at the upper deck.

It should be noted in passing that with the oil hatches on the shelter deck it is not advisable to locate the living quarters amidships directly on the oil-tight deck. To overcome this, on all vessels of this type the accommodations have been raised 3 feet 6 inches off the shelter deck, leaving an open space under the house. The house plating is extended down to the deck on the front and sides, but is open for access at the after end. The house with this construction requires particularly secure fastening to the shelter deck.

It is impossible to avoid bringing up some of the valve operating rods into this space under the house, but these are extended out clear by means of bevel gears.

There have recently been built, or are now building, several shelter-deck vessels in which the oil hatches are located on the upper deck, and the 'tween-deck space is entirely open, without gas trunks, but the majority of the shelter-decked ships are now of the type just described, namely, with the trunk to the shelter deck. This type is highly satisfactory for an all-around tanker.

A recent special design which is worthy of note is embodied in the tanker *D. G. Scofield,* in which the entire 'tween-deck space, between upper and shelter decks, is made suitable for carrying case or barrel oil, in addition to the bulk cargo in the tanks. The oil hatches are on the upper deck and large cargo hatches are provided in the shelter deck each side of the center strake, which is continuous. Three masts are fitted with complete cargo-handling gear consisting of booms and winches. This is another instance, however, of adaptation of a tanker to special trade. Such package cargo-handling equipment on the majority of tankers would be useless.

In considering the subject of shelter-decked tankers, the question naturally arises as to what determines whether a vessel shall be built with a shelter deck or a forecastle, bridge and poop deck. The answer is somewhat obscure, but the determining factors seem to be mainly matters of size and of personal preference. The dividing line seems to be in the neighborhood of 10,000 or 11,000 tons deadweight, the vessels above that size being almost without exception shelter-decked vessels.

The main point involved is one of draft. Increasing the size of the vessels it is not desirable to increase the draft in proportion. The shelter-decked type lends itself to carrying an increased deadweight on a limited draft without adopting extreme proportions. The shelter-decked type is also preferable for strength purposes in the larger sizes.

With regard to tonnage openings, a few shelter-decked vessels of this nature have been built, and they have the advantage of small tonnage measurement combined with good structural design due to small length to depth ratio; but the greater depth required tends toward a heavier ship.

For purposes of comparison I have made a rough approximation of the general characteristics of four steamers, each of 11,000 tons deadweight capacity but of different types, as follows:

1. Shelter-decked vessel with expansion trunk carried to shelter deck.
2. Shelter-decked vessel with oil space up to upper deck only; no tonnage openings.
3. Same as (2) but with tonnage openings.
4. Forecastle, bridge and poop type.

In working out the dimensions the length and beam were kept constant and the depth and draft allowed to vary to suit the different conditions.

The following table gives the results of the calculations, which have not been carried out to any degree of refinement but which are sufficient to indicate what may be expected of the different types:

COMPARISON OF FOUR TYPES OF TANKERS OF 11,000 TONS DEADWEIGHT EACH

Type	L.	B.	Draft	Depth to Upper Deck	Depth to Shelter Deck	Displacement	Weight of Ship Light	Cargo Capacity, Cubic Feet	Gross Tonnage
1....	450′	59′	26′ 4″	28′ 0″	35′ 6″	16,270	5,270	483,000	7,900
2....	450′	59′	25′ 6″	27′ 10″	35′ 4″	15,700	4,700	420,000	7,850
3....	450′	59′	26′ 0″	31′ 0″	38′ 6″	15,800	4,800	458,000	7,750
4....	450′	59′	26′ 6″	34′ 0″	....	16,000	5,000	460,000	7,850

From the table it will be noted that type (1), although a heavy ship, has great cubic capacity, and is therefore best adapted to carrying light grades of oil. Type (2) is a lighter ship, for reasons previously explained, but has small cubic space and is therefore suitable only for heavy oil trade. Type (3), on account of the tonnage openings, requires great depth, resulting in increased weight of hull and increased cubic capacity. Type (4), it will be noted, requires greater draft and is rather heavy but has plenty of room inside.

It must be remembered that all of these vessels will carry a deadweight of 11,000 tons, and therefore the variations and possibilities with the deadweight fixed, and even with length and breadth fixed, are apparent. The results go to show that the vessel, when designed, must be made to conform to the conditions under which it is intended to operate.

In the matter of cubic cargo space, for instance, let us assume that for a vessel of this size the fuel carried will be 1,050 tons, with 250 tons fresh water, stores, etc. This leaves 9,700 tons for cargo, which, if heavy fuel oil, occupies 358,900 cubic feet; if refined oil, 436,500 cubic feet; and, if naphtha, 485,000 cubic feet. A study of these figures will readily give an indication of the respective capabilities of the vessels.

The foregoing types were assumed to have the usual sheer line, the middle portion of which, if faired on the ¾-inch lines, would show an easy curve. It must be noted, however, that there is a growing tendency at present to adopt a straight sheer line amidships, and, in fact, there are tankers now under construction embodying this idea.

Effect of Straight Sheer

In order to investigate the effect of the straight sheer, the sheer line in type (1) was changed and made straight for 55 percent of the length amidships, fairing into the original height at the ends. This change made an increase in the molded depth to shelter deck of 2¾ percent. The principal objection to the straight sheer is the reduction in height of shelter deck for a space beginning at the stem and extending to a point about 35 percent of the length abaft the stem, where the old line crosses the new. The greatest reduction in height occurs between 15 and 20 percent of the length abaft the stem. The reduction amounts to only a few inches and is not a serious difficulty.

With the new sheer line, the allowable draft will not be noticeably changed, and the difference in hull weight will be negligible. The advantage structurally of the straight sheer is obvious, as it will permit practically universal work throughout almost the entire length of the oil space, and the frames, bulkheads, etc., will be alike for every tank except the end ones.

Subdivision of Cargo Tanks

A prominent feature of recent construction has been the subdivision of the cargo tanks into groups for the carrying of different grades of oil. If two different grades are separated by a single bulkhead there is danger that a leak in the bulkhead, permitting a mixing of the grades, will spoil the cargo. The first step was to place the pump room amidships, which, aside from being a most convenient location for pumping, divides the tanks ino two groups in which different grades of oil can be loaded without danger of mixing.

This was carried further and cofferdams inserted between the tanks. The 15,000 ton deadweight tankers previously mentioned have ten main cargo tanks divided into three groups with a separate pumping system for each. Several smaller tankers have similar divisions.

This is another example of the incorporation of special requirements for special trade. As an extreme case, there is one vessel now building on the Atlantic coast which has five cofferdams and a pump-room dividing the cargo tanks into four separate blocks. One of the cofferdams, however, is located between the after fuel tank and the fire-room. Many of the modern tankers have this arrangement, which is a wise safety precaution originated on account of fires started by oil in the fire-room due to leaky bunker bulkheads.

Where such cofferdams are built, they are provided with tunnels for use in the event of the vessels burning coal. The tunnels are blanked by oil-tight bolted doors on each end, but if used for coal the oil-tight doors will be removed and vertical sliding bunker doors fitted. The fuel-oil piping passing through the cofferdam is fitted with a valve on each bulkhead, the valve on the bunker side being controlled from the deck. The cofferdam is also provided with a sea valve controlled from the deck, for flooding in case of fire. Thus, if a fire originates in the boiler room, it can be isolated from the fuel supply, while if the fire starts in the tanks the propelling machinery can be kept intact.

Cylindrical Tanks

An important feature of the tank steamer situation is the construction of steamers with cylindrical tanks. Six of this type of vessel have been built or are being built by the Chester Shipbuilding Company. Aside from the saving in hull weight in this type, it has the advantage that the cylindrical tanks can be constructed by people other than shipbuilders. Under the present conditions this fact bears considerable weight. The present design shows a series of tanks the diameter of which is as great as the vessel's framing will permit. A recent design which places smaller tanks on opposite sides of the center line appears to have an advantage with regard to preventing listing of the vessel.

If it is desired to carry cargo or ballast outside the cylinders—that is, between the cylinders and the ship's sides—it is important that the head of water or oil outside the cylinders be not greater than that inside, and for this purpose automatic non-return valves are provided.

The cylindrical tanks are particularly well adapted to conversion jobs, and the few recent conversions of general cargo vessels to tankers have been on this basis. It is a remarkable fact, in view of the great demand for tank tonnage, that so few vessels have been converted to bulk-oil carriers, and rather reflects the skeptical attitude of the shipping community toward converted vessels.

Adoption of Rolled Tee-Bar Section

Returning to the ordinary tanker and coming down to structural features, it appears that the greatest single item which made for better construction has been the adoption of rolled tee-bar section for oil-tight work. Until recently, tee-bar was not generally rolled for ship use and was unobtainable in proper sizes. Under pressure from shipbuilders and shipowners, however, the mills have adopted this section in several sizes and the advantages of its use in the construction of tankers are generally recognized.

Tee-bar is now being used for the bracket connections of longitudinals to bulkheads, and is replacing single and double-angle connections for this purpose. It has the advantage of being made oil-tight much more readily than the angle connections, for the double-angle clips have a habit of leaking at their ends, and the single-angle clip gives difficulty along its heel.

The usual size of tee-bar for bracket connections is 6½ inches by 6½ inches by .45 inch, double riveted in both flanges. Where this replaces a single-angle clip 3½ inches by 3½ inches, single riveted, it is apparent that an equal number of rivets can be obtained in a much shorter tee-bar clip. It is inadvisable, however, even with equivalent rivet connections, to reduce the depth of the brackets on account of using shorter tee-bar clips, and the tendency is, therefore, to use longer tee-bar clips than the riveting requires in order to maintain the effective portion of the brackets.

A further use of tee-bars is for bounding connections on oil-tight work. On some of the shelter-decked tankers just built, in which the expansion trunk is carried to the shelter deck, the bar is used to connect the upper-deck plating to the expansion trunk bulkheads, with excellent results. If a single angle were used instead, the heel would require to be calked for the entire length.

Tee-bar is also being used to connect the top of the fore deep tank (under the forward hold) to the fore-peak bulkhead and to the forward cofferdam bulkhead. The shell connection, where the heel need not be calked, is angle bar, and this butted against the tee-bar and straps fitted. The Sun Shipbuilding Company is using tee-bar for the boundaries of the transverse oil-tight bulkheads, and, while the writer has approved this as an emergency measure, there is some question whether double bounding angles are not necessary to maintain proper oil-tightness.

The use of the tee-bar for bilge-keel attachments has long been established as the only thoroughly satisfactory connection, and recent experience has indicated that these tee-bars should be at least 9/16-inch thick.

Use of the Multiple Punch

One other feature is of great importance for oil-tight work, namely, the multiple punch. This has not been used extensively up to the present, but its possibilities are so great that it is believed this machine will soon be in common use in building tankers. The first requirement for oil-tight work is that the rivet holes shall be fair—a result which, unfortunately, is not always obtained with the common single punch, especially when operated by a gang on piece-work. By using the multiple punch, the holes are spaced mathematically correct; every space is exactly the same as every other one, therefore the holes cannot fail to match when the work is erected. If, therefore, the multiple punch will insure fairness of holes, its importance for oil work is obvious. In addition to this advantage, the actual cost of punching, reaming, riveting and testing will undoubtedly be lowered, while the actual laying-off of the work for punching is entirely eliminated where this punch is used.

It must be understood that this type of machine imposes severe restrictions on the rivet-spacing, and it is only by painstaking care in the original design and in developing the riveting details that the multiple punch can be used. The chief difficulty is that the spacing in frames or longitudinals must be exactly twice that in seams and butts, which may involve some additional rivets not required by the rules. The spacing in way of bulkheads and transverse frames presents a knotty problem, and it may be that some holes will have to be single punched or drilled.

The multiple punch is, of course, only suitable for work on the dead flat, but if properly worked out it can be used on a very large portion of such work and will result in making the parts universal to a far greater extent than at present.

In view of the large number of tankers recently sunk by submarines, many of which have been in ballast, con-

siderable thought has been given to the question of ballasting in order to give the most favorable conditions if torpedoed. The ballast condition of a tanker is a variable quantity, as it may be altered at will to suit weather conditions or for other reasons. Many claim that if all tanks are filled with water to bring the ship to her load draft, and several tanks are then pierced by explosion, the condition of trim and list will be changed but little, whereas if some of the tanks are empty and then pierced the vessel will settle, due to filling the tanks previously empty, and will list as well, due to the additional water on one side only. On the other hand, if water is carried in all the tanks, obviously some of them must be slack tanks and be even more likely to cause listing.

Protection Against Torpedoes

After carefully considering the subject, the writer's conclusions are: First, that no slack tanks should be carried, thereby eliminating this danger from listing. Second, that the vessel be given as much reserve buoyancy as possible, which may be the means of saving the ship if torpedoed in the machinery space; therefore as little ballast should be carried as weather conditions will permit, but whatever is carried should be in full tanks so distributed as to equalize the loading to best advantage. Third, that gate-valves be fitted in the center-line bulkhead near the bottom of each tank, operated from the deck, but left open at sea; thus, if empty tanks are pierced, the water will equalize and prevent listing.

Experience indicates that a torpedo explosion shatters the structure in the vicinity and renders it non-watertight or non-oiltight for a considerable radius. If several tanks are full, the water or oil in them, being practically non-compressible, transmits the shock and destroys the watertightness for a much greater radius. This is another reason for having empty tanks. If the shock of explosion is so transmitted by water in the tanks as to cause the fuel-oil bulkhead to leak into the fire-room, the ship is doomed; therefore anything making this a possibility must be avoided.

Standardization

With reference to the subject of standardizing, this is a matter which has been in the air for some time, and the standardization of tankers has been discussed on many occasions.

So far as the standardization of fittings is concerned, there are great possibilities in this direction. It is understood that the Bethlehem Steel Corporation has already taken steps to standardize fittings in its various plants, and it is to be hoped that this will include fittings for tankers, such as oiltight hatches, shell manholes, tank ladders, cargo pipe fittings, valve operating gear, heater coils, gas vents, etc. It would be of great advantage if standard fittings of this nature could be adopted by all the shipyards in the country.

As to standardizing tankers themselves, it would be interesting to note that the 64 tank vessels now under construction in American yards represent nineteen distinct types or designs and are being built in sixteen different shipyards for sixteen different owners, considering vessels building for "foreign account" as being under one owner. At least there were sixteen different owners prior to August 3, at which time all these vessels were requisitioned by the United States Shipping Board, Emergency Fleet Corporation. The construction of these vessels is now in the hands of the Corporation, represented by the district officers; at the urgent request of tank-ship owners, the district officers have retained the services of the former owners' inspectors, in order that inspection by men thoroughly trained in oiltight work might be assured.

The nineteen types above mentioned range in size from 5,000 tons to 15,000 tons deadweight and represent almost every possible variation in design. They were designed by competent men to meet specific requirements. Practically every oil company and every shipyard has its own standard type of tanker, or in many cases three or four standard types, all varying in accordance with the different needs of the business and with the different ideas as to how these needs are best met.

It has already been pointed out that special vessels are required for special trades in order to obtain the best results. A vessel designed to carry heavy oil is not suitable for transporting refined oil, and vice versa. A vessel designed for straight cargo is not suitable for a mixed cargo, but a vessel designed for mixed cargo is needlessly complicated and expensive for shipping straight cargo. Owners trading on the west coast only, naturally desire to take advantage of the deep water to adopt wholesome proportions of length to depth, whereas other owners, trading in ports where draft is restricted, must adopt different proportions. Some trades require vessels with fuel capacity for ten days, others for forty days. In many cases large vessels are the most economical, but large vessels cannot be built in all yards and cannot enter all ports.

It is obviously impossible to find a single vessel to meet all requirements, and if an attempt at a compromise is made it will place practically every oil company at a disadvantage in having to operate vessels which are not quite suitable.

The nearest approach to efficient standardization would be in the adoption of at least four standard designs, consisting of two vessels, a large one and a small one, for the sole purpose of carrying cargoes of heavy oil and two vessels, a large one and a small one, especially for carrying mixed cargoes of light oil.

In carrying heavy oil, such as fuel oil or crude oil, it is possible to load different kinds in the same vessel without danger of mixing, due to leakage or due to pumping one kind through the same pipe line as another. Therefore there is no need of subdividing the tanks for different grades.

The smaller vessel for this purpose would naturally be of the forecastle, bridge and poop type, and the larger one of the shelter-decked type. In both cases small fuel tanks for bunker use are sufficient, as it is possible for a long voyage to carry half a main cargo tank of fuel, or to carry it in summer tanks. The permanent fuel-oil tanks should consist of a short tank at the forward end of the cargo tanks, and another at the after end, thus enabling the vessel to be trimmed as the fuel is used. With this arrangement no cofferdams whatever are required in the vessel. The pump-room in this type of vessel should be located between the after-fuel tank and the boiler-room, thus separating the oil from the fires, and should contain the fuel-oil pumps and heaters as well as two cargo-oil pumps. A simple system of cargo-oil piping whereby both pumps can draw from the tanks and discharge overboard independently is sufficient. The summer tanks may be fitted with drop-valves, connecting them with the main tanks, or they may be piped for fuel oil, as conditions require. All tanks in these vessels should be fitted with heater coils.

For the standard vessels intended to carry mixed cargoes of light gravity oils, the smaller would be of the forecastle, bridge and poop type and the larger of the shelter-decked type with expansion trunks carried up to the shelter deck. In both vessels rather larger fuel-tank capacity

is required. On account of the danger in carrying naphtha next to fuel oil, cofferdams should be provided at each end of the cargo tanks. The cargo pump-room should be located amidships, thus dividing the cargo tanks into two groups. For safety, a cofferdam between the after fuel tank and the fire-room should be provided and the oil-burning apparatus installed in a separate enclosure in the fire-room wing. A fuel pump is required forward to transfer fuel aft from the forward tank. The cargo oil piping system should permit of the pumping of different grades of oil from the forward and after groups of cargo tanks simultaneously and independently, without the two grades using any piping in common. The cargo piping must not extend into the fuel tanks. The summer tanks should be piped separately. Special precautions against gas must be provided, and the gas vents from the tanks fitted with automatic relief valves. Special ventilation for the pump-room and cofferdams must be furnished.

The foregoing outlines briefly the minimum that could be expected in the standardization of tankers. Assuming, however, that such standard designs were prepared and approved, it is not clear just what would be gained by throwing out all the present designs and adopting new standard designs. The vessels now building were designed especially for certain definite purposes, best known to their original owners, and it is not likely that standard designs would serve such purposes any better. The ships now building are duplicates of other ships previously built in the same yards, and the experience gained on the previous vessels is an asset not lightly to be ignored. The advantage of having all plans, material orders, templates and patterns for existing vessels places a handicap on standard ships which will take time to overcome, and the result would be to slow up construction instead of speeding up.

Unquestionably, the quickest and most economical means of building additional tankers is to duplicate existing vessels, for which the designs are already perfected and which conform specifically to the needs of the oil business. In this way only can the cheapest and quickest construction and the greatest economy of operation be attained.

Future Prospects of Tankship Construction

The future tankship construction is, however, an uncertainty. All of the vessels now under construction are for 1917 or 1918 delivery. When these vessels are completed, the building of tankships will, according to present indications, be at a standstill in this country. So far as we are aware, the United States Shipping Board has not, up to the present time, made any provision for tankers in its shipbuilding program. The board is promoting the construction of a huge fleet of cargo carriers to transport supplies to our allies and to handle the nation's increasing commerce; but it has entirely ignored one of the most important of the Allies' necessities and one of our own principal industries in excluding tankers from its programme.

The nation's oil business has advanced with enormous strides and is still advancing. The demand for tank-steamer tonnage is greater than ever, and new vessels will be needed constantly to meet the ever-growing transportation requirements. We have lost many tank ships through war causes and will undoubtedly continue to lose them. In spite of all this, there is no provision for future requirements. Oil companies and shipbuilders have endeavored to obtain the board's permission to proceed with tankship construction, but up to date this permission has not been granted.

The present situation is, therefore, that the Shipping Board is placing no new orders for building tankships and will not permit anyone else to do so. This policy can have but one result, and, if immediate steps are not taken, we shall unquestionably be faced by grave shortage of tank-steamer tonnage. This condition is most serious and urgent and demands the earnest consideration of all shipping men having the nation's welfare, and the cause in the great struggle which it represents, at heart.

BOOK REVIEWS

The Aldrich Marine Directory. Compiled by H. L. Aldrich. Size, 4½ by 8 inches. Pages, 202. New York, 1918: Aldrich Publishing Company. Price, $5.

With the rapidly increasing size and importance of marine industries in the United States, a complete directory of American shipbuilders and ship owners is indispensable. To meet such a need, the Aldrich Marine Directory has been carefully compiled, giving lists of concerns in the United States which build and repair vessels, and also lists of steamship, steamboat and other vessel owners using the American flag. No attempt is made to classify the vessels owned by the government, although the various departments of the United States Government have under their control considerably more than 1,000 steam vessels.

The list of shipbuilding and repair yards is arranged according to the location of the yards geographically, and is divided into four distinct groups—those on the Atlantic coast, the Mississippi Valley, the Great Lakes and the Pacific coast. In each case the names of the officials of the yard, its capacity, number of launching ways and the nature of the work are given. The list of vessel owners is arranged in a similar manner and gives not only the names of the officials of the steamship and steamboat companies, but also the names, gross tonnage and service of the vessels owned by the companies.

The book is of pocket size, and as the data which it contains are tabulated, the work forms a most convenient ready reference book.

Heat. By John Roger. Size, 4½ by 6¾ inches. Pages, 77. New York, 1917.

Physicists, who are not satisfied with the ordinary treatment of the subject of thermodynamics, will find the subject attacked in this pamphlet from an entirely new viewpoint.

The author starts out by defining heat as a diamagnetic or negative force, acting in opposition to the positive force of atomic attraction, and temperature as the negative atomic stress produced between the atoms. He shows that the working value of the unit of heat is not 778 foot-pounds, but is proportionate to the temperature.

There is no such thing as latent heat, he says, only developed and undeveloped energy. It is shown that the properties of different forms of matter cannot be compared by quaitities of equal weight, but that the specific heat of different materials should be dealt with by equal volumes. According to the author, the specific heat of matter has no apparent relation to the atomic weights.

Such features of the pamphlet as have been indicated above should at least be sufficiently striking to arouse the interest of those who have been baffled by the inconsistencies of thermodynamics as usually presented.

Rear Admiral Francis E. Bowles has been made assistant manager of the Emergency Fleet Corporation, with headquarters in Philadelphia in order to speed up work at the new government yards.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs.

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Repairs Made on a Cracked Pump Cylinder

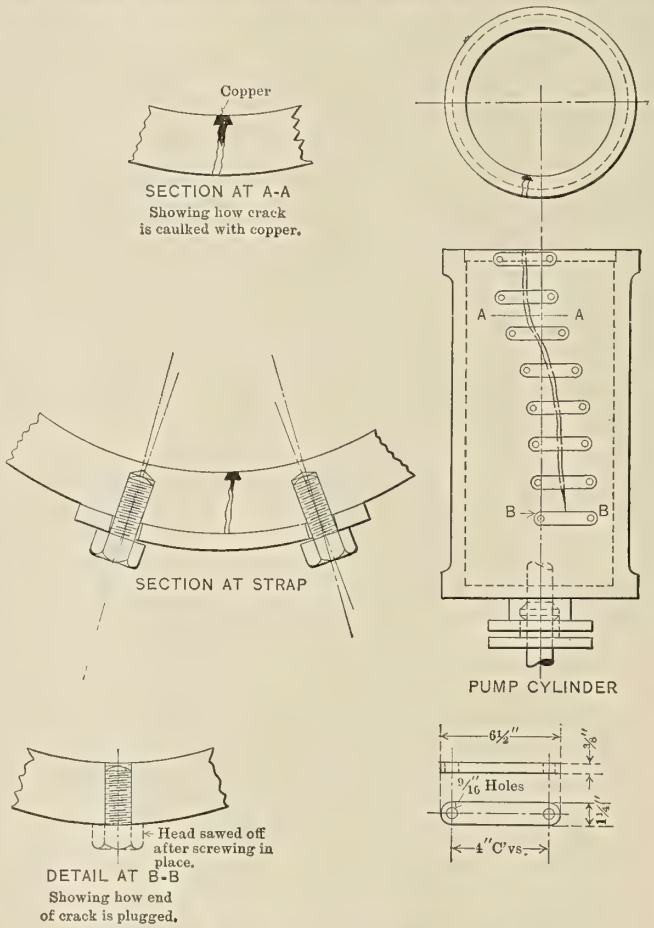
My feed pump cracked while at sea when our vessel was not far from a small southern port. Although it was possible to run the ship without the pump, the owners thought it best to stay in port until the ship's full pumping capacity could be used. As the steam cylinder was cracked for three-quarters of the length, and, on account of the general shape of the cylinder, bands could not be used, the port representative of the owner had about made up his mind that it was necessary to send for a new cylinder. The writer happened to remember, however, of a similar case which had been repaired in the following manner, and was given forty-eight hours to try it out in.

We had some flat iron lying around, and I had it finished into strips, as shown in the sketch. To keep the crack from lengthening, a hole was drilled and tapped out and a ½-inch bolt put in and the head knocked off flush after screwing up solid. This is shown in section *B-B*. Then 2 inches to the left of the crack, starting at the lowest part of the crack, ½-inch holes were drilled and tapped out, being careful not to drill clear through the cylinder. As this was a vertical pump, the holes were spaced 3 inches apart vertically. These holes, instead of being drilled in a line—that is, run true to the center of the cylinder—were toed in slightly. The reason for this will be shown later. A stud was carefully fitted to each hole and the stud and hole marked with corresponding numbers. The strips were then heated to a low temperature so they would bend easily, and bent to the outside radius of the cylinder.

As the cylinder was sprung considerably towards the top of the crack, a strong clamp was fitted about this time and the crack was pulled together. The strips were fastened by the studs in their left ends and each strip marked for this definite position. Any final touches to fit the strip closely to the cylinder were then made. The holes drilled in the right end of the strip were very carefully scribed on the cylinder and the strips removed.

Now comes the part of the job upon which success depends. The cylinder must be pulled together and firmly held by the power of contraction of the strips in cooling off after being heated up. As the elastic limit of the strips is reached when the stretch is 1/50 inch and the pull exerted at that length is about 8,000 pounds, which was sufficient for our needs, there was no need of giving the strip more stretch than that, notwithstanding the fact that that amount of elongaion can be obtained with a comparatively small temperature rise (some 400-odd degrees). This, however, is a good thing, in that it gives us a margin of action in slow work between the forge and bolting up in which there is sure to be obstacles which, even if small, take up time while the strip is cooling.

The center of the lowest hole, therefore, was marked 1/50 inch to the right of the position scribed on the cylinder when the strap was in place. If the crack were closed tightly together at all points this would be the proper allowance for each strip, but, as this is never the case, the engineer must use his judgment as to the proper allowance for each strap. The distance depends upon the amount the crack is sprung, upon whatever, if anything, is holding it apart, and also upon the length of the strip,



Details of Repairs to Cracked Pump Cylinder

allowing an elongation of 1/200 inch in every inch length of strip between stud hole centers. Possibly this amount can be allowed in extreme cases where the crack must be pulled together through considerable distance, but, if the crack can be partially closed in that way, this is not advised. On my job, as the crack was pulled pretty well together, I increased the spacing from 1/50 inch at the bottom to 1/25 inch at the top. It must be remembered that the holes in the strips are 1/16 inch larger than the studs, and allowance must be made for this by pulling the strip to its extreme right-hand position and then measuring for the center from the right-hand mark of the scriber. These holes are drilled and tapped, being toed in and also drilled part way through, as in the other side of the crack.

The studs are fitted and marked, as on the other side, and then the straps are placed in a forge handy to the cylinder. While a couple of men heat them up, two others work at the cylinder setting them on. Speed is necessary here as well as system, for the strips should be put on while at the maximum temperature (a good red heat is

sufficient here), and the strips should follow each other as close as possible. The strips are put on, starting at the bottom and working toward the top. The studs are toed in, so that the strip will tend to hug the cylinder, thus binding the whole together.

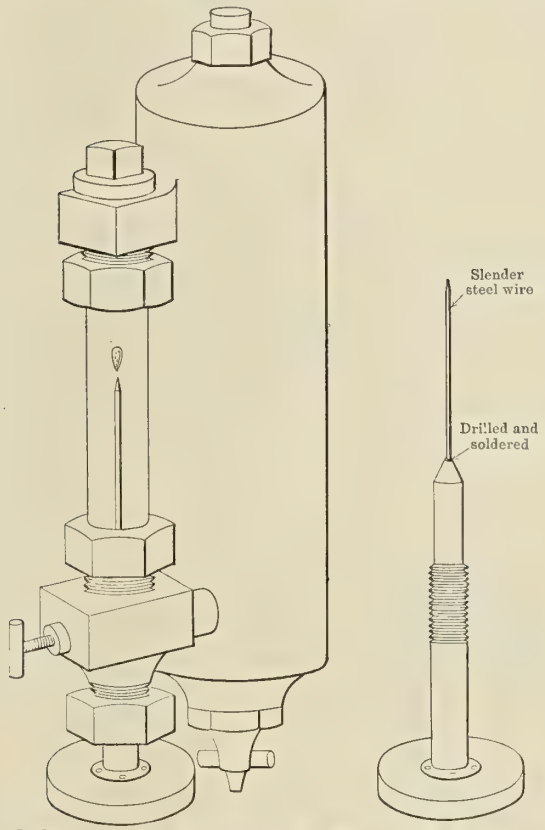
To make the job steam-tight, I made some dovetailing tools out of files and other scrap aboard, and cut a dovetail along the crack, as shown in section *B-B*. I then hammered out some strip copper into a wedge and hammered it into the crack, calked it in and finished it over with the ball peen, finally scraping it smooth. The hardest part to get tight is the bottom of the crack, where the stud was put in. By using a little care, however, this is not very difficult.

The pump was set up and working thirty-six hours after the inspection by the owner's representative, and as long as I was on the vessel it worked perfectly, and so far as I know is still standing up to the work. As the time necessary for getting a new pump cylinder to this port would have been nearly two weeks and the cost a considerable amount, I figured that the emergency repair was worth the try.

J. P. Knoblauch,
First Assistant Engineer, S. S. *W. C. Teagle.*

Keeping the Sight Glass Clean

Most engineers know what a lot of trouble it is to keep the inside of a sight feed glass of any lubricator clean, and if they are not kept clean one cannot tell how they are



Lubricator with Attachment for Keeping Sight Glass Clean

feeding half the time. One of the watch engineers devised a scheme, which is illustrated in the sketch, of having the drop of oil impinge and travel on a slender wire two-thirds of the length of the glass. This keeps it clear of the side of the glass. The wire is secured to the valve spindle, as shown at *A*.

The scheme works well, and saves much bother and many glasses, for in the frequent cleaning of the dirty glasses many would get cracked and broken by the handling. We had experimented with the kink of putting a bit of common yellow soap into the lubricator when filling. This kink is an old one, but we never could get satisfaction from it, though it did help for a short time after soap was placed in.

Concord, N. H. C. H. Willey.

Use of the Telephone for Finding "Shorts" in Electric Wiring

Having found the feeder, or wire in which the "short" has occurred, it is still often the hardest part of the work to locate its exact position. Sometimes it will show itself by heating up the wire in the neighborhood, but very often there is no indication whatever, especially such as can be seen by the practiced eye, where some of the cables are fixed on board ship. The first thing to be done, however, should be to go carefully through the whole of

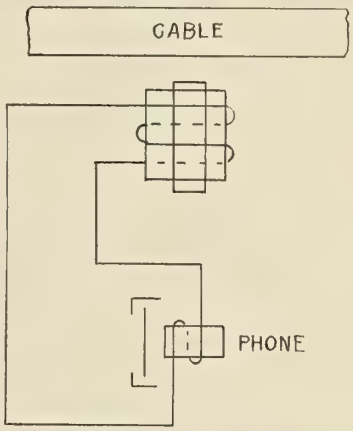


Fig. 1.—Diagram Showing the Arrangement of a Telephone and a coil of wire with which to exlore the cable for a "short."

the cable or wire in which the "short" is; if it is possible the cable or wire should be passed through the hands, but care must be taken to avoid shocks in doing this. If many "shorts" occur in the cables of the ship, considerable skill will soon be acquired in noting what would be very minute indications. If there is no indication that is of any service, the telephone can be brought into use, and will indicate the position of the "short" to a dead certainty.

For the purpose, one of the telephones that are used by operators in telephone exchanges or wireless stations may be used, though it should be wound differently from those. The headgear telephone, in which one or two receivers are held to the ears by a strap across the head, is recommended because it leaves the hands quite free.

The idea underlying the telephone test is: A very moderate current is sent through the cable in which the "short" occurs, the current that can be obtained from one or two dry cells, for instance, and that will produce no appreciable heating effect; if it is interrupted periodically by any convenient method, any form of make and break, and a telephone is brought near the cable in which the interrupted current is passing, a click will be heard in the telephone every time the circuit is made and every time it is broken. If the telephone receiver is a fairly sensitive one, or if the current that is made and broken is fairly powerful, the click will be heard in the phone strapped on the head, without any accessories.

As the testing may have to be carried out in awkward and noisy places, the action of the make and break can be multiplied by forming a secondary circuit, in which

the telephone and a small coil of wire contained on a reel will be included, as shown in Fig. 1. The best results will usually be obtained if the winding of the small coil be of about the same resistance as that of the telephone, though it may be of fairly large diameter.

Improved results will be also sometimes obtained if a dry cell is included in the circuit, as shown in Fig. 2; a

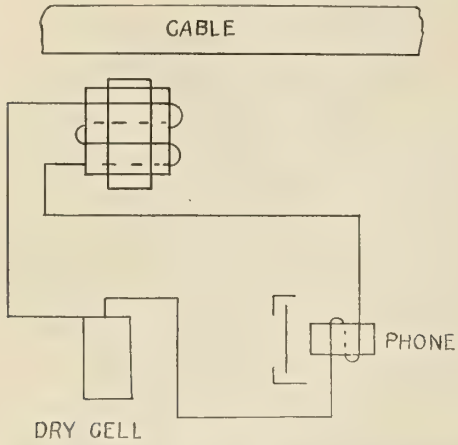


Fig. 2.—Diagram Showing a Similar Arrangement; an exploring coil, a telephone, but with a dry cell included in the circuit.

very small cell that can be carried in the pocket, or can be attached to the coil, will answer the purpose.

The make and break may be done by hand; say by an assistant touching the end of a wire on its terminal, say the wire that is connected to the terminal screw of the

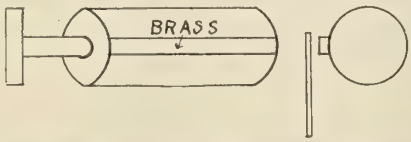


Fig. 3.—Diagram Showing a Revolving Make-and-Break Apparatus

dry battery; or if it is inconvenient to have an assistant, a simple form of make and break could easily be devised, such as that shown in Fig. 3, driven by an electric motor or a belt from any convenient source of power. The

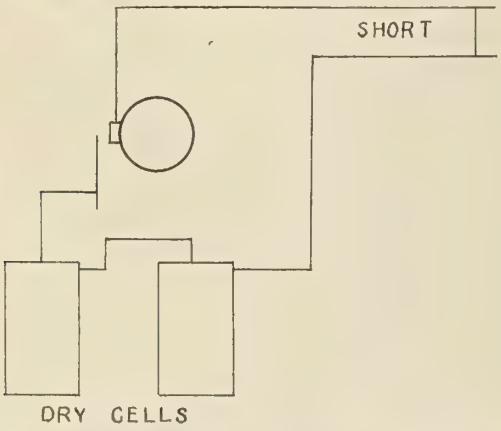


Fig. 4.—Diagram Showing the Arrangement of the Connections for Testing for a "Short," with a Couple of Dry Cells Connected to the Two Cable Conductors, the Current Passing Through the Make-and-Break. The Cables Are Shown by the Lines Joined at the Short, and the Make-and-Break Is Shown Above the Dry Cells on the Left.

make and break, as will be seen, consists of a cylinder of insulating material, a piece of dry wood would answer very well, on the surface of which one or more strips of brass is mounted. A brass spring is made to bear on the surface of the cylinder and the connections are as shown in Fig. 4. The brass spring and the brass strip on the wood cylinder form the stationary and moving parts of the switch; when the brass strip is under the spring, the switch is closed and a click will be heard in the telephone, and when the brass strip leaves the spring the circuit will be opened and another click will be heard in the telephone.

The operation of the apparatus is as follows: The telephone having been strapped on the head and connected to the reel of wire, and the circuit of the contact breaker and battery having been formed with the cable to be tested, the operator works outwards from the switchboard where the last lamp indications were obtained, holding the exploring coil, the reel of wire, close to the cable to be tested. As long as he is on the near side of the fault he will hear the click of the telephone at every make and break, and when he has passed the fault the clicks will cease.

The procedure is exactly the same where there are two faults on two cables, the positive and negative; but each cable must be tested separately and the connections of the make and break circuit must include earth.

In some cases where the fault is not a complete short circuit, where the resistance of the fault is high, not sufficient to cut off the current entirely from everywhere else, the indication by the telephone will not be so clear as where there is a dead short; but a little practice will enable sufficiently clear indications to be obtained to enable the position of the fault to be located. The clicks in the telephone will have a certain vigor up to the position of the fault, and will then begin to be less and less, so that by working forwards and then backwards the position of the fault will be sufficiently clearly indicated.

Bath. SIDNEY F. WALKER.

Kinks from the Note Book

It has been a profitable hobby and a mighty useful one to the writer to gather into a note book the ideas and kinks applicable to his calling. When visiting aboard another ship or when on shore and nosing around the stationary plant and machine shops, I have found many kinks and data to add to my own original thoughts in the note-book. From time to time I have contributed to the trade

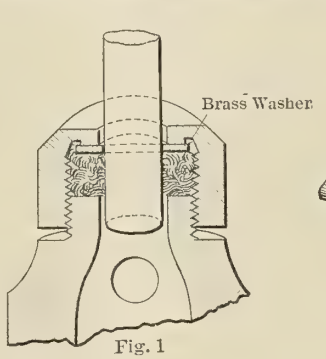


Fig. 1

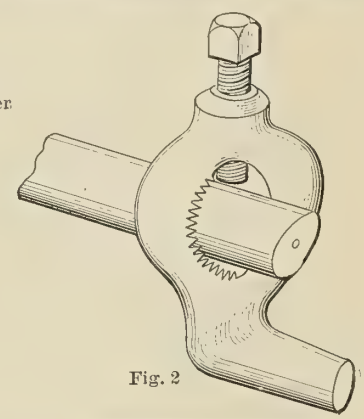


Fig. 2

NOTCHED LATHE DOG

Handy Kinks to Be Remembered

papers many of these ideas, and thereby have passed along to others anything found worth while. The kinks shown in the sketches are a few taken from this note-book and are in most part original. While they are quite simple, they are nevertheless useful.

When tightening upon a gage glass packed with rubber grummits we often find that the packing has adhered to the inside of the packing nut and will not readily turn. Often it results in a broken glass. The sketch shows a stunt that serves very well to cure this disagreeable trouble. A metal washer is placed inside the packing nut as shown in Fig. 1. The washer must be an easy fit to both the nut and glass. With this washer in place, the grummit is prevented from sticking to the nut, and it is easily taken up when leaking.

Fig. 2 shows how to make a sure-grip lathe dog. The ordinary dog will often slip on round stock when a heavy

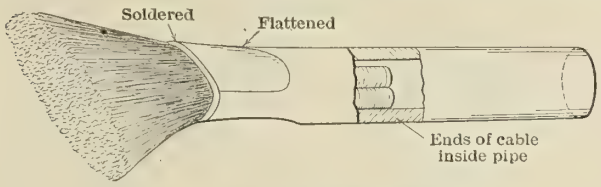


Fig. 3.—Wire-Cleaning Brush

cut is being taken. If serrated with a file on the inside, as shown, the gripping quality is greatly improved and less pressure or strain is required of the set screw. Should the dog be needed for a finished piece of work, a piece of

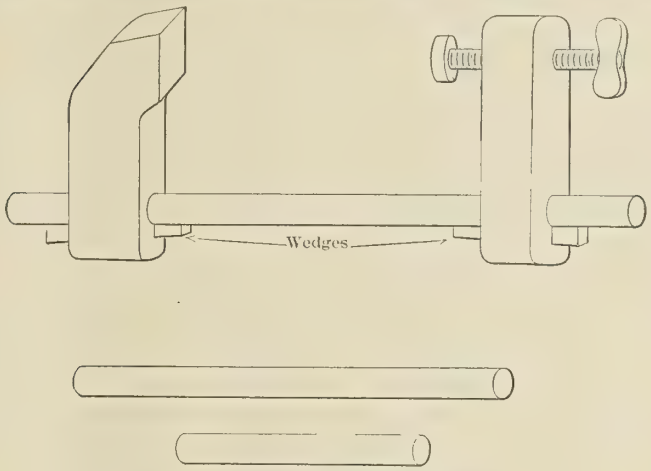


Fig. 4.—Variable Length Bar Clamp

soft brass can be used over the end that enters the dog, the same as when avoiding a set screw impression.

Fig. 3 shows a very good way to make wire cleaning brushes for cleaning the chips out of the slots of the planer, milling machine and shaper, table slots, and for any such work; they are very durable. Short lengths of old small size pipe serve for handles. Two short lengths of ⅜-inch old wire cable are inserted into the end of the

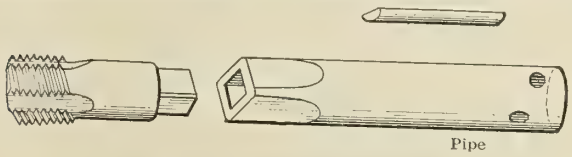


Fig. 5.—Extension Tap Wrench

pipe, and then the end of it is smashed down with a hammer or squeezed flat in a vise, and the cables soldered to the neck as shown. The many strands are teased out to form the brush and are cut even at the ends.

Fig. 4 is termed a variable length clamp; is a very useful tool and quite easily made. The heads or jaws are made from solid bar stock 1½ inches square. The holes for the round bar are of ¾ inch diameter, and at one side of each hole is cut a tapering keyway for the securing wedges shown. This clamp can be adapted to suit a wide range of dimensions, for any length of ¾-inch round bar can be called into use in the jaws.

Oftentimes one has to tap out a pulley, a gear hub or similar part, and the hole is so inaccessible that some extension is required for the tap. I have always had excellent results with the socket extension tap wrench made from pipe, as shown in Fig. 5. Steel tubing is best, if obtainable. Tubing or steel pipe offers a wide variety of sizes from which to make socket wrenches.

Concord, N. H. Chas. H. Willey.

Unique Marine Accident

Extraordinary accidents, due either to human fallibility or to circumstances over which control is difficult to exercise, or imagination to foresee, do happen. Most of these provide a useful lesson, especially where the consequences are fatal or where large sums are involved. A history of industrial accidents would be worth compilation. It would range between unprotected gear wheels and boiler explosions. Every accident, by which term is meant an undesirable happening which takes place against the will and wish of the man in control, has a reason behind it.

Some ship happenings are so mysterious that the charter and bill of lading always exclude liability for act of God, wind or weather, and the consignee finds that this covering clause is made to do duty through a very wide range. As a protest can be sworn before a notary public for a very modest fee, the ship, in the person of her chief mate, contrives most often to escape liability for damages to cargo. Deck cargo, for which the ship invariably disclaims liability, is subject to jettison on very slight provocation. In this case the will of decision of the master is above the law, and for this reason deck cargo is always a considerable risk to the consignor. The intricacies of marine insurance were always puzzling and need a Philadelphia lawyer to unravel, but the ship's master in practice obeys very simple and practical rules in connection with his duties. The substances commonly termed chemicals are first among the slaughter of the innocents, largely because the ship's officers are naturally ignorant of their nature.

The latest accident to a ship, involving her total loss from a combination of circumstances probably unique even in the annals of the sea, was recently given in the daily press. As it serves the purpose of warning, it is worth circulation where it will be seen by those in a position to safeguard risk.

"It was stated at the inquest yesterday that the explosion which wrecked the Grimsby trawler *King Harold* was caused through a drum of calcium carbide being accidentally dropped into the engines, which pounded it to pieces.

"The carbide came in contact with water in the bilges, and the acetylene thus generated exploded, wrecking the ship and killing three men."

Thus the extract from the *London Daily Chronicle* of October 24, 1917.

Familiarity may breed contempt, and those most used to danger are apt to become indifferent through use and habit; still, the fact that a drum of carbide should be so handled or positioned that the accident was possible points a useful warning.

London. A. L. Haas.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

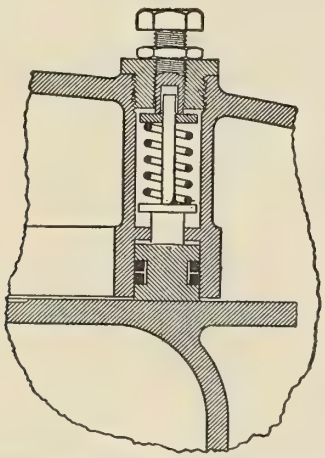
This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number if from examination for grade of chief, and by a dagger (†) if from examination for other grades.

Equilibrium Ring on Flat Slide Valve

Q. (931).—What is the purpose of an equilibrium ring on the back of a flat slide alve, and how is it fitted up?

A. (931).—With large slide valves and where the lubrication is scanty, the frictional forces, due to the steam pressures, exert an unnecessary strain on the eccentrics. As a means of obviating this, equilibrium rings are fitted on the backs of the valves. The function of the equilibrium ring is to prevent excessive pressures on the back



Section Through Equilibrium Ring

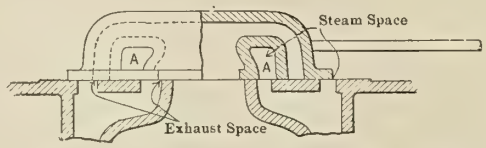
of the valve, and it accomplishes it by making a tight joint with the back of the valve. The space within the ring is connected usually to the condenser. The back of the valve is thus relieved from excessive steam pressure, and, as a consequence, the sliding friction is largely reduced.

Contiguous with the inner face of the valve chest is a grooved ring. A second ring is placed within the first and forced against the back of the valve by means of springs. The back of the valve is faced off to give a running fit between the ring and the valve.

Double Ported Valve

Q. (932).—What is a double-ported valve, and what is the purpose of this style of valve?

A. (932).—Since steam increases rapidly in volume in expanding, the steam ports of the low pressure cylinders of multiple expansion engines are necessarily large. This large port area would require the use of a large eccentric, and, as a consequence, the considerable expenditure of



Section Through Double-Ported Slide Valve

power to work it. To avoid this, a double- or triple-ported valve is employed, the former more generally.

The second, or extra, ports are marked *A*, and steam enters these ports from both sides of the valve.

Remedy for Sediment in Feed Heater Tubes

Q. (936).—What will dissolve sediment which collects in feed heater tubes?

A. (936).—I know of nothing that will be effective for all sorts of sediment that is not injurious to the tubes. A well-operated marine plant should not have much sediment in the tubes, as a filter should be in the line leading to the heater, and the water is practically freed from scale-forming material when it leaves the hot-well. For shore plants the problem is as complex as that of the feed water and needs individual study for each case.

Ratio of Expansion

Q. (935).—What is meant by ratio of expansion?

A. (935).—Neglecting clearances, as is commonly done, the ratio of the volume of the low pressure cylinder to the volume of the high pressure cylinder at cut-off is the ratio of expansion. For example, a compound engine

$$\frac{\text{10 inches by 20 inches}}{\text{12 inches}}$$

with cut-off at three-fourth stroke, has an expansive ratio of

$$e = \frac{\text{Vol. L. P.}}{\text{Vol. H. P. at C. O.}} = \frac{\frac{\pi 20^2}{4} \times 12}{\frac{3}{4}\left(\frac{\pi 10^2}{4} \times 12\right)} = 5\tfrac{1}{3}.$$

The expression

$$e = \frac{\text{Vol. L. P.}}{\text{Vol. H. P. at C. O.}}$$

can be reduced to

$$e = \frac{(\text{L. P. Dia.})^2}{(\text{H. P. Dia.})^2 \times \text{percent C. O.}},$$

for the above case

$$e = \frac{20 \times 20}{10 \times 10 \times .75} = 5.33.$$

A triple expansion engine

$$\frac{19 \times 31 \times 54}{42},$$

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

with a high pressure cut-off at 60 percent of stroke, has an expansive ratio of

$$e = \frac{54^2}{19^2 \times .6} = \frac{2{,}916}{361 \times .6} = 13.45, \text{ or approximately } 13\tfrac{1}{2}.$$

The ratio of expansion is also called "number of expansions" by many writers.

Capacity of Circular Tank

Q.* (940).—How many gallons of oil will a circular tank 50 inches in diameter and 7 feet 5 inches high contain?

A. (940).—The contents of the tank are

$$\frac{3.14 \times 50 \times 50 \times 89}{4} = 174{,}700 \text{ cubic inches.}$$

As 231 cubic inches = 1 gallon, therefore 175,000 ÷ 231 = 756 gallons.

Diameter of Donkey Pump to Get Higher Pressure

Q.* (941).—If a donkey pump, having a water end 5 inches in diameter and a steam cylinder 6 inches in diameter and 70 pounds of steam, will pump a pressure of 100.7 pounds, and you wanted to change the water end so as to pump a pressure of 157½ pounds, what diameter of water end would you require?

A. (941).—The force acting on each end must be equal, and as the force on a piston is proportional to the pressure and the square of its diameter, the direct solution is as follows:

$$\frac{(\text{Diameter water end})^2}{(\text{Diameter steam end})^2} = \frac{\text{Pressure on steam end}}{\text{Pressure on water end}}$$

$$\frac{(\text{Diameter water end})^2}{(6)^2} = \frac{70}{157\tfrac{1}{2}}$$

Diameter water end = 4.0 inches.

The same result is obtained by the more detailed method of equating the forces acting on each piston.

Force on water end = Force on steam end

or

Press. × area (water end) = Press. × area (steam end)

$$157.5 \times \text{area water end} = 70 \times \frac{\pi \times \overline{36}^2}{4} = 1{,}979$$

$$\text{Area water end} = \frac{1{,}979}{157.5} = 12.58 \text{ square inches}$$

Diameter water end = 4.0 inches.

Cushioning Engine Piston

Q.* (943).—If an engine required more cushion than the lead furnished, the load being right, what alteration in the valve would be required to obtain it?

A. (943).—Shorten the lap on the valve, or, if the cards including that from the other end of the cylinder can stand it, changing the length of the valve rod will accomplish the same purpose—i. e., with a slide valve taking steam on the outside and driven without a rocker, shorten the valve rod to increase head end lead and compression.

Advancing the eccentric will also advance all operations of the valve to occur earlier in the cycle.

Operation of Ship with Air Pump Broken

Q.* (944).—How would you bring a ship into port with the air pump broken down beyond repair?

A. (944).—Cut out the air pump completely and lead the exhaust line from the condenser around the air pump and directly into the hot well. If the pump barrel is not broken, remove all pump valves to give a clear lead through the pump and let the condensate and air take its normal course to the hot well. Operate the circulating pump at a speed sufficient to condense all steam and make sure that the hot well is uncovered to avoid undue pressure on the condenser. You can then operate the engine, but the power will be reduced by the work formerly made available by the vacuum (probably nearly all of the low pressure cylinder) and some vapor will come out into the engine room.

Rules for Fitting Gage Cocks and Safety Plugs

Q.† (945).—What are the rules for fitting gage cocks and safety plugs, and at what temperature will a safety plug melt?

A. (945).—The General Rules and Regulations of the Board of Supervising Inspectors (ocean and coastwise) require all boilers, except flash boilers, shall be supplied with at least three gage cocks attached directly to each boiler. When the gage cocks are connected to the boilers by a water column there shall be three additional gage cocks inserted in the head or shell of boiler. The lower gage cock in boilers more than 48 inches in diameter shall be not less than 4 inches above the top of the flues, tubes or combustion chambers. In boilers less than 48 inches in diameter the lower gage cock shall be not less than 2½ inches above the top of the flues, tubes or combustion chambers.

Double-end boilers shall have at least three gage cocks at each end.

In vertical boilers or boilers of the watertube type the location of the lowest gage cock shall be determined by the local inspectors.

A safety plug should melt at about 450 degrees F.

Inspection of Scotch Boiler

Q.† (946).—You are sent to inspect a Scotch boiler. Explain in detail what you would do.

A. (946).—The boiler should be examined thoroughly inside and outside.

If the boiler is covered, a sufficient portion of the covering should be removed as may be necessary to properly examine the surface. The joints, longitudinal and circumferential, should be inspected, particular attention being paid to the plating.

The internal inspection should consist of an examination of shell, joints and furnaces. The braces should be examined to see that they are of the correct size and in place. The main defects to look for are pitting, corrosion and scale. The internal fittings, such as hydrokimeter, dry pipe, etc., should be noted. A summary of defects most commonly met with is given below:

(1) Deposits of sediment, (2) incrustation and scale, (3) internal grooving, (4) internal corrosion, (5) external corrosion, (6) defective braces and stays, (7) settings defective, (8) furnace out of shape, (9) fracture of plate, (10) burned plates, (11) laminated plates,, (12) defective riveting, (13) defective heads, (14) defective tubes, (15) leakage around tubes, (16) tubes too light, (17) leakage at joints, (18) water gages defective, (19) blow-offs defective, (20) deficiency of water, (21) safety valves overloaded, (22) safety valves defective, (23) pressure gages defective, (24) pressure gages lacking.

Relative Position of Distiller and Evaporator

Q. (951).—Does the vertical position of the distiller in relation to the evaporator have any bearing on its efficincy?

A. (951).—It has no bearing on the efficiency of the plant, but if located fairly high above the distiller pump, that unit operates better mechanically, and also there is less danger of salt water being carried over from the evaporator due to priming.

Shipbuilding and General Marine News

Contracts for New Ships—Shipyard Improvements—Engineering Projects—Improved Appliances—Personal Items

OUTPUT OF MERCHANT TONNAGE FROM AMERICAN SHIPYARDS

American shipyards turned out 901,223 gross tons of merchant vessels in 1917, according to reports made to the Shipping Board. This was nearly double that of 1916, and almost half of the world's output of 1,899,943 tons of that year.

Figures showing the construction in other countries in 1917 are not available, although it is known that English yards are rapidly increasing their output, and Japan has also greatly increased its ship production, although limited by the lack of steel. Other countries are building few ships.

Production in 1918

An output of from 4,500,000 to 5,000,000 tons deadweight is confidently predicted by Chairman Hurley of the Shipping Board for the current year, provided the shipbuilding industry continues to operate on its present basis. This prediction is based on estimates from Lloyd's special agents after a careful survey of the shipbuilding situation of the country last December.

More than 300,000 tons of shipping will be added to the American merchant marine during the first two months of 1918 through the completion of commandeered vessels. During January, 18 vessels, with an aggregate deadweight tonnage of 145,091, are scheduled for completion, and it is expected that 23 vessels, with a total deadweight tonnage of 182,061, will be completed in February. The ships for the most part are cargo vessels and tankers, originally ordered by private owners but subsequently commandeered by the Government.

Shipways Available

When the Emergency Fleet Corporation was organized there were available for merchant shipbuilding in the United States 148 ways. To-day there are available 716 ways finished or under construction; 95 percent of them are completed, and on every way that is ready a keel has been laid.

Approximately 300 ways are for wooden shipbuilding, the remainder for steel. A fair estimate offered by Chairman Hurley of the Shipping Board is that from each wooden shipbuilding way two ships will be turned out in a year, and from each steel shipbuilding way three vessels.

Shipyard Labor Increasing

On October 13 there were employed in 118 shipyards engaged in work for the Emergency Fleet Corporation 105,497 workers. By December 21 this force had increased to 171,274, a gain of 65,777 men, or 62.3 percent.

Reports from 52 steel shipbuilding plants showed a gain in the number of workers employed for this period of 60 percent. These yards employed 93,048 men on October 13 and 148,462 on December 21—an increase of more than 55,000. The other plants reported are wooden shipbuilding yards; their combined forces were increased during this period 81 percent.

Shipping Board Asks for $783,000,000

Requests from the Treasury Department ask Congress to increase by $783,000,000 the estimated appropriations for shipbuilding for the next fiscal year. This sum will bring the total appropriations for shipbuilding next year above $2,000,000,000.

The new estimates include $701,000,000 for ship construction, bringing the total appropriations for that purpose up to $1,935,000,0000, and $82,000,000 for shipbuilding plants, bringing the total for that purpose up to $247,000,000.

Thus far the Shipping Board has been authorized to spend for shipbuilding $1,234,000,000, contracts for most of which have been awarded. The additional appropriations called for will be used largely for additional fabricated steel ship contracts.

Of the $82,000,000 asked for additional shipbuilding plants, about $35,000,000 will be used for housing the workmen at the plants.

Watertube Boilers Recently Approved by the Steamboat Inspection Service

Under the provision of Section 4429, Revised Statutes, the executive committee of the Steamboat Inspection Service has approved the following watertube boilers: Modification of Emergency Fleet Corporation's standard watertube boiler, presented by the Emergency Fleet Corporation. Washington, D. C.; C. H. watertube marine boiler, presented by the Casey-Hedges Company, Chattanooga, Tenn.; Connolly standard watertube boiler of the drum and bent tube type, and the Connolly watertube boiler of the header and straight tube type, presented by the D. Connolly Boiler Company, Cleveland, Ohio; the Wickes marine watertube boiler, presented by the Wickes Boiler Company, Saginaw, Mich.

Other marine appliances recently approved by the Steamboat Inspection Service include the Hill's boat releasing gear, presented by the New York Shipbuilding Corporation, Camden, N. J.; the Aaron fire extinguisher, soda and acid type, 2½-gallon machine, manufactured by the Robinson Fire Apparatus Manufacturing Company, St. Louis, Mo., and valves and fittings manufactured by the Old Dominion Iron Works, Berkeley, Va.; O'Malley-Beare Valve Company, Chicago, Ill, and the Yarnall-Waring Company, Chestnut Hill, Philadelphia.

Appropriations Asked for Navy Increase

In the Naval Bill for this year an appropriation of $212,488,000 is asked for increasing the navy. Provision is made for continuing the three-year programme of ship construction started in 1916. No additional funds are asked for the destroyer programme, which was provided for in an emergency appropriation made during the last session of Congress.

Included in the total appropriation for the increase of the navy is $94,000,000 for aviation and $4,000,000 for the improvement of shipbuilding yards.

Canadian Shipbuilding Programme

Hon. C. C. Ballantyne, Minister of Marine and Fisheries of the New Union Government in Canada, has outlined plans designed to utilize to the fullest capacity Canadian shipyards and to establish rolling mills as essential to that industry. The output of these yards at present may be roughly estimated at from 275,000 to 300,000 tons annually.

The programme, as outlined, calls for an expenditure of from $50,000,000 to $60,000,000 annually for ocean-going cargo vessels, to be built under and operated by the Canadian Government.

Thirty More Lake Steamers to be Placed in Atlantic Service

Thirty large lake steamers, with an aggregate tonnage of more than 100,000, are to be placed in the transatlantic service by the United States Shipping Board as soon as navigation opens in the spring. In all, the Great Lakes will add more than half a million tons to the Atlantic fleet in the spring of 1918.

Vessels building on the lakes for the Shipping Board total nearly 450,000 tons, while forty vessels were brought down from the lakes in 1917, with an aggregate tonnage of 135,000.

Shipbuilding School Opened on Staten Island

In order to assist the United States Government in its shipbuilding programme, the city of New York, through its Department of Education, has opened an evening school for shipbuilders at Public School No. 20, Port Richmond, Staten Island, N. Y. Approximately 5,000 men are now engaged in shipbuilding on Staten Island, and within a year this force must be increased to 12,000 men. The courses offered in the school are planned to be of immediate value to the men now employed in the shipbuilding yards, and also for the training of the new men who are continually going into the yards. The courses offered include a beginners' course for mold loftsmen; an advance course for

mold loftsmen; a beginners' course for ship fitters; a course in blue print reading, layout work and a study of constructional requirements and a course for riveters.

There are three distinct classes of men in the shipyards who need training: First, the men who have been employed in shipbuilding for a number of years who need supplementary instruction in blue print reading, mathematics, layout work and building requirements, so that the men can qualify for positions as foremen and assistant foremen; second, the training of men from allied trades, and, third, the educating of men, such as salesmen, laborers and clerks, without mechanical experience, and training them to do a special type of work in the shipyards. It is to fill this need that the school has been opened.

American Ships Sunk by the Enemy

According to figures carefully compiled and recently published by the *Journal of Commerce*, a total of 79 American vessels of 201,397 gross tons have been sunk by the enemy since the war began, with a loss of 313 lives. A summary of the losses by years is given in the following table:

Year—	Vessels Lost	Gross Tonnage	Lives Lost
1915	7	16,067	4
1916	3	12,426	0
1917	68	170,106	301
1918	1	2,798	8
Totals	79	201,397	313

An inspection of the detailed list of losses shows that since 1915 all sinkings have been caused by submarines with the exception of two schooners, which last June were sunk in the Pacific by a German cruiser. In 1915 five American vessels were lost by striking mines and one was sunk by a raider. A large proportion of the total losses consisted of sailing vessels, 35 out of the 79 vessels lost being sailing vessels.

First Motor Ship Runs 210,000 Miles

Since the end of 1910, and up to the beginning of December, 1917, the little motor ship *Vulcanus*, says The Anglo-Saxon Petroleum Company of England, who are the managers for the owners (the Nederlandsche - Indische Tank Stoomboot Maatschappij), has run 210,000 nautical miles, and her engine is still in good order and condition. In view of the fact that she is a very full-bodied tanker of but 7½ to 8 knots loaded speed, and of only 500 brake-horsepower, this is a very fine record.

She has a beam of 37 feet 9 inches and a length of 196 feet. Her loaded displacement is 2,080 tons, and she has a carrying capacity of 1,235 tons on a draft of 10½ feet, and a daily fuel consumption of fourteen barrels of crude oil fuel. She is fitted with a 6-cylinder, 4-cycle type, 15¾-inch by 23⅝-inch Werkspoor reversible Diesel engine. On a voyage of 66 steaming days her total oil-fuel consumption was 134 tons (938 barrels). On more than one occasion she has run for eighty-eight days without rebunkering, although she only carries less than 200 tons of fuel.

The *Vulcanus* is of interest because she was the first ocean-going, full-powered reversible Diesel-driven ship placed in service. For two years she ran on Taraken crude oil, having a specific gravity of 0.950 at 15 degrees C. On this oil her fuel consumption was guaranteed at 0.42 pound per shaft-horsepower at full load. Her trial speed was 8.4 knots.

New Intensive Naval Architecture Course at the Massachusetts Institute of Technology

Such has been the demand for men conversant with naval architecture, and so instant was the placing of men trained in this specialty on the occasion of the previous course, that the Massachusetts Institute of Technology is offering another course similar to that of six months ago. It will be an intensive course in naval architecture, which will begin February 4 and end about May 24, open to the graduates of technical schools and other persons having the same preparation. This course, under Professor C. H. Peabody, gives a good training in theoretical principles and in ship design, and it goes without saying that there will be a demand for men who show ability in these studies. Students in the course will have the privilege of taking other work at the Institute for which they may be qualified.

Students already registered at the Institute will pay for the special term $25 in addition to the regular tuition fee for the second term. Those who register for the intensive course only will pay full tuition for a term, namely, $150.

The text books required are "Naval Architecture," Peabody, and "Practical Shipbuilding," Holmes, to be obtained at the Technology Branch, Harvard Co-operative Society.

For further information and registration apply to Professor C. H. Peabody, Department of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Concrete Cargo Ships to Be Constructed by the Shipping Board

The Shipping Board, in co-operation with the Bureau of Standards, will undertake the construction of concrete cargo ships. This decision follows an investigation by the Bureau of Standards of the 5,000-ton concrete vessel now under construction at San Francisco. The Shipping Board has already negotiated a provisional contract with Matthew Hale, of Boston, for the construction of twenty concrete ships of 3,500 tons each by a Boston company to be called the Liberty Shipbuilding Corporation. The contract provides that a concrete vessel now under construction by the Boston concern be accepted by the Emergency Fleet Corporation.

In presenting the proposal to the Shipping Board, Mr. Hale represented that the plans of his clients had been approved by marine experts of the Massachusetts Institute of Technology.

The Shipping Board is further considering the construction of concrete barges to be used in the coastwise traffic.

NEWS ITEMS FROM THE SHIPYARDS

Additions and Improvements

New Shipyards Projected

According to report, O'Connor-Bennett, Inc., consulting engineers, 45 East Forty-second street, New York, in co-operation with the Union Dry Dock & Repair Company, Weehawken, N. J., have taken over a large tract of land near Port Jefferson, L. I., with the intention of building a yard for the manufacture of coal barges for the Navy Department. It is reported that an order has already been received from the United States Navy Department to build eight of these barges, each to cost $125,000.

It is reported that the Foundation Company, E. E. Jenkins, purchasing agent, 233 Broadway, New York, which has already established yards in the Hackensack Meadows, Portland, Ore., and Vancouver, Wash., plans the construction of another yard at Seattle, Wash., to have ten ways.

W. H. Garland, 404 Dock street, Wilmington, N. C., president of the International Navigation Company, is reported to be planning the establishment of a shipyard near Southport, N. C.

The Alabama Dry Dock & Shipbuilding Company, E. L. Merkel, Jr., purchasing agent, Mobile, Ala., is planning the erection of a 10,000-ton drydock to be used especially for repairing Government vessels.

The G. M. Standifer Construction Corporation, J. J. Burke, purchasing agent, Portland, Ore., is making plans for a million dollar steel plant, and is reported to have received contracts to build ten steel freight ships for the United States Shipping Board.

It is reported that C. D. Logan, manager of the Rayburn Lumber Company, is planning to build a shipyard at Apalachicola, Fla.

It is reported that Louis Van Horn, Washington, D. C., is planning the erection of a shipyard to build fabricated steel ships for the Government.

Emery M. Newton, 601 Keyser building, Baltimore, Md., is planning to organize a company to erect a shipyard for building steel vessels.

Mayor E. T. Woodman, Los Angeles, Cal., announces that a new steel shipbuilding plant is about to be built at Los Angeles.

The Norway-Pacific Construction & Dry Dock Company, Everett, Wash., M. G. Thomle, president, will, according to report, build a shipyard to be equipped for building both steel and wooden vessels.

The Todd Shipyards Corporation, 15 Whitehall street, New York, has purchased the Puillon Shipyard, foot of Clinton street, Brooklyn, N. Y.

The Houston Shipbuilding Company, Houston, Tex., has been incorporated to build a shipyard. A. D. Boice, Houston, is a stockholder.

It is reported that Henry Ford, the automobile manufacturer, Detroit, Mich., will erect a large shipyard somewhere on the South Atlantic coast to build a special type of vessel for the Government.

The Hydro Barge Company, Penns Grove, N. J., is planning to build a shipyard near Norfolk, Va., for the construction of concrete barges and ships.

The Liberty Shipbuilding Company, Boston, Mass., is planning to build a shipyard near Savannah, Ga.

The Hanlon Dry Dock & Shipbuilding Company, Oakland, Cal., has acquired additional land, and will install machinery to build steel in addition to wooden ships.

It is reported that the Union Construction Company has acquired a site of land in San Francisco Bay, Oakland,

Shipbuilding Contracts

Chairman Hurley of the United States Shipping Board, Washington, D. C., has asked a supplementary appropriation of $484,000,000 for the construction of ships for 1919.

A bill has been introduced into the New York Legislature to appropriate $950,000 for the construction of barge canal terminals at Kingston, Newburgh, Poughkeepsie and Yonkers.

(Copyright by Committee of Public Information)

German Submarine Surrenders to U. S. Destroyer *Fanning*

Cal., with the intention of building a shipyard.

It is announced that the Norway-Pacific Construction & Dry Dock Company, Seattle, Wash., will construct a ship-building plant at Everett, Wash., at a cost of $1,500,000, to build steel ships.

John L. Hall, Henry building, Seattle, Wash., is one of those who have organized the Lake Washington Shipyards Company.

The Superior Shipbuilding Company, Superior, Wis., is adding three berths to its yards, making a total of seven.

The Mann Shipbuilding Company, Light street, Baltimore, Md., is having plans prepared for a shipbuilding plant on Curtiss Bay.

The San Diego Bay Shipbuilding Company has been incorporated by W. J. Strachan, Carl F. Enper, J. Burris Mitchell and others, all of San Diego.

The Liberty Shipbuilding Company has been incorporated in Boston, Mass. Max Shoolman, 372 Chestnut Hill, Boston, is treasurer.

John F. Craig, Long Beach, Cal., has purchased the plant and Government contracts of the California Shipbuilding Company, Long Beach, Cal.

The old paper-making plant of the Colonial Paper Company, Portsmouth, N. H., has been acquired by the Atlantic Engine & Shipbuilding Company, Boston, Mass. It is said that a shipyard will be erected on this site and that the company will build ten steel ships for the Shipping Board.

The Louisiana Shipbuilding Corporation is the new name of the reorganized Slidell Shipbuilding Company at Slidell, La.

The Pensacola Shipbuilding Corporation, F. M. Blaunt, general manager and purchasing agent, Pensacola, Fla., is reported to have received a contract from the United States Shipping Board to build ten 9,400-ton steel freight ships.

The Pacific Coast Shipbuilding Company, Mill City, Cal., is reported to have received a contract from the United States Shipping Board to build ten 9,500-ton steel steamships, in a yard to be built at Bay Point, Cal.

The Grays Harbor Shipbuilding Company, W. R. Osborn, purchasing agent, has received a contract from the United States Shipping Board to build four wooden freight ships of 4,000 tons each.

The Bayles Shipyard, Inc., Port Jefferson, L. I., L. Deyo, purchasing agent, 115 Broadway, New York, has a contract from the United States Shipping Board to build four steel steamships.

The United States Shipbuilding Company, San Diego, Cal., is reported to have received a contract from the United States Shipping Board to build eight steel steamships of 8,800 tons each.

The Peninsula Shipbuilding Company, H. H. Fisher, purchasing agent, Portland, Ore., has contracts from the United States Shipping Board to build six or more wooden steamships, in addition to the eight vessels, contracts for which have already been reported.

Babare Bros., Tacoma, Wash., have received a contract from the United States Shipping Board to build two wooden steamships of 3,500 tons each.

The Moore & Scott Iron Works, T. G. Otis, purchasing agent, Oakland, Cal., are reported to have received a contract from the United States Shipping Board to build ten 9,400-ton freight steamships and six 10,000-ton oil tank steamships.

The McAteer Shipbuilding Company, O. J. Ramm, purchasing agent, Seattle, Wash., is reported to have received contracts to build two wooden freight ships for Norwegian interests.

The New Jersey Dry Dock & Transportation Company, Patrick Higgins, president, Elizabethport, N. J., is building two steel tugs for the Central Railroad of New Jersey, 143 Liberty street, New York, and one steam lighter for the Lehigh Valley Railroad Company, 143 Liberty street, New York.

Frank C. Adams, East Boothbay, Me., is building a 152-foot wooden auxiliary three-masted schooner from designs by John G. Alden, of Boston, Mass.

William H. Baldwin, New Baltimore, N. Y., is building a 65-foot wooden tug for the Red Hook Towing Company, Brooklyn, N. Y.

E. James Tull, Pocomoke City, Md., is building two wooden barges for the Diamond P. Barge Line, Philadelphia, Pa.

The International Marine Iron Works, Houston, Tex., has a contract, said to amount to $2,500,000, with the International Shipbuilding Company to equip with machinery the ships which the International Shipbuilding Company is building in its yards at Gulfport and Pascagoula, Miss., and Orange, Tex.

H. D. Cabell, vice-president of the Clayton Ship & Boat Building Corporation, Clayton, N. Y., announces that his company has decided to build four barges of 750 tons capacity for traffic on the New York State Barge Canal, and that it is planning to build a large number of additional barges for concerns now in course of organization.

Charles W. Morse, 50 Broad street, New York, who has recently organized the American Shipbuilding Company, with a site on the Potomac River at Alexandria, Va., is reported to have received a contract from the Shipping Board to build twelve 8,800-ton steel ships.

The York River Shipbuilding Corporation, Ripley Bowman, purchasing agent, West Point, Va., has received a contract from the Shipping Board to build eight wooden hulls of the Ferris type. These boats will each have a net tonnage of 3,500 tons.

The Standifer Shipbuilding Company, Portland, Ore., is reported to have received contracts from the U. S. Shipping Board Emergency Fleet Corporation to build ten 8,800-ton steel vessels. It is also reported that the company has secured a site of land for an additional shipbuilding plant at Vancouver, Wash.

Capt. D. M. Swain, Stillwater, Minn., has placed a contract to build thirty-six barges and two tugs.

The Greenwich Piers Marine Railway Company, Greenwich Piers, N. J., is building a wooden tug for Gayley, Davis & Company, Philadelphia, Pa.

The Lake Erie Dry Dock & Engineering Company, Sandusky, Ohio, is reported to have received a contract from the Shipping Board to build ten 260-foot steamships.

The Memphis Steel Construction Company, Memphis, Tenn., has received a contract from the War Department, Washington, D. C., to build a steel barge.

The Dravo Construction Company, Wheeling, W. Va., has secured a contract from the War Department to build seven motor boat hulls.

Electric Mono-Rail Hoists for Handling Ashes

When up-to-date boiler houses are designed, the problem of handling the ashes is now always considered. A mono-rail electric hoist, with a bottom dumping bucket, as illustrated, which is

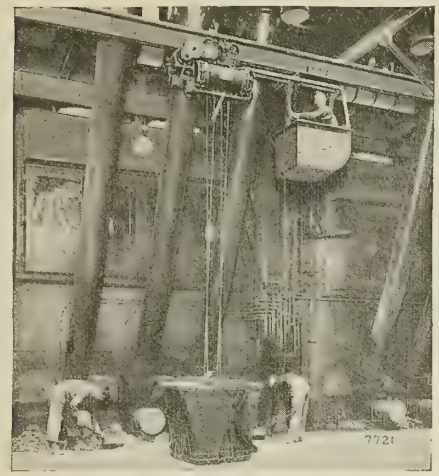


Fig. 1.—Machine in the Boiler House

manufactured by the Link-Belt Company, Chicago, Ill., is a type of machinery which lends itself readily to such installations. This is especially true where the ashes are pulled out on the boiler room floor, which is so often the case.

This machine runs on the lower flange of an I-beam track. It is operated by a man traveling in a trailer cage, who controls the raising or lowering of the bucket as well as the travel hoist. Fig. 1 shows the machine in the boiler house through which the track runs and continues on out over a railroad siding, as shown in Fig. 2.

The laborers who clean the fires fill the bucket with ashes. The operator

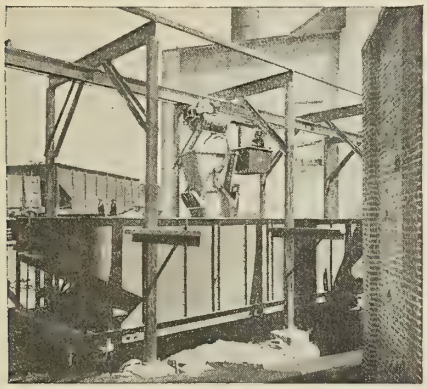


Fig. 2.—Dumping Ashes in Railroad Car

then hoists his bucket and runs it out directly over the car, where he dumps it by the motion of a lever in the cage. The current required is very small. By comparing this method with that of wheeling ashes, a marked saving in time will be apparent.

In many installations where an overhead bin or suspension bunker cannot be installed, on account of lack of space, for supplying coal to the stokers, it may then be practicable to use the same mono-rail hoist system to handle the coal as well as the ashes. Fig. 3 shows a tipping bucket about to discharge coal into a stoker hopper. Better even than this, a bucket with a small chute and undercut grate is often used.

This problem of handling ashes mechanically is daily becoming more urgent. Many boiler rooms are now running 24 hours a day where two years ago they were running ten—hence over twice the ashes to handle and with labor so scarce.

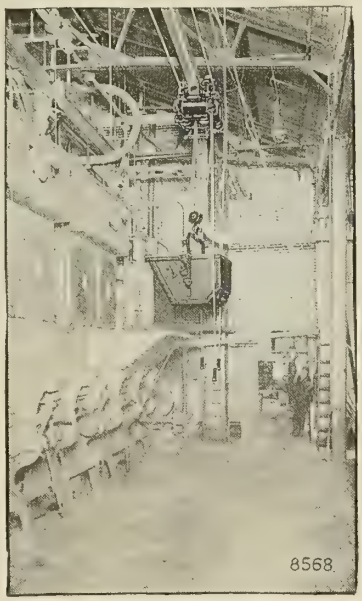


Fig. 3.—Coaling Boilers with Tipping Bucket

Many plants have put in stokers and forced draft systems to increase their capacity, often neglecting to provide for the handling of the ashes when the remodeling is done. The electric hoist fills a long-felt want in this field.

Students in Shipping Board Schools Exempted from Military Duty

Official announcement was made January 19 by Henry Howard, Director of Recruiting for the United States Shipping Board, that under a recently issued regulation of the Provost Marshal General's Department all students entering Shipping Board schools for deck officers or engineers, will be exempted from military duty, and will remain exempted so long as they pursue the calling for which the school fits them. This affects six hundred or more students now in Shipping Board schools, and will apply to students enrolled in the future.

There are now thirty of these schools training deck officers for the merchant marine and eight training engineers. Only men who have had two years' seafaring experience are admitted to the schools. About four thousand new officers for the merchant marine have been licensed since the United States entered the war.

More Ships Traversing the Panama Canal

Traffic through the Panama Canal last year increased largely over the previous years, according to the annual report of Col. Chester Harding, governor of the canal. A total of 1,876 vessels of all classes passed through the canal from July 1, 1916, to June 30, 1917, inclusive.

Of these, 905 passed from the Atlantic to the Pacific, and 971 from the Pacific to the Atlantic. In the fiscal year 1915, 1,088 vessels passed through the canal, and in 1916, 787. The total number of vessels transiting the canal since it opened for commercial traffic in August, 1914, is 3,751. The total net tonnage, canal measurement, for the several years is as follows: 1915, 3,849,035; 1916, 2,479,762, and 1917, 6,009,358. The cargo tonnage transported was, for 1915, 4,969,792; 1916, 3,140,046, and 1917, 7,229,255.

Scarcity of Skilled Labor

Unusual difficulty was experienced in securing an adequate supply of skilled mechanics in the United States for duty on the Isthmus, especially in the shipbuilding and repairing trades, due to the abnormal activities in the various manufacturing plants and shipyards. Fifty-four percent of those tendered employment failed to accept, as against 48 percent during the preceding fiscal year.

Ship Draftsmen Are Needeed for Emergency Fleet Work

The Civil Service Commission issues the following:

There are not enough ship draftsmen in the United States to do the drafting work needed to carry out the naval and merchant shipbuilding programmes. Our country is engaged in the execution of the greatest warship construction plan in history, comprising 787 vessels, including all types from superdreadnaughts to submarine chasers. Naval appropriations aggregating nearly two billions of dollars have been made since August, 1916.

Technical Men Needed

Coincident with the demand for increased naval work there is an equally urgent call for an increase of merchant ship construction. It is betraying no secret to say that in both branches there is a shortage of technical men available for the work.

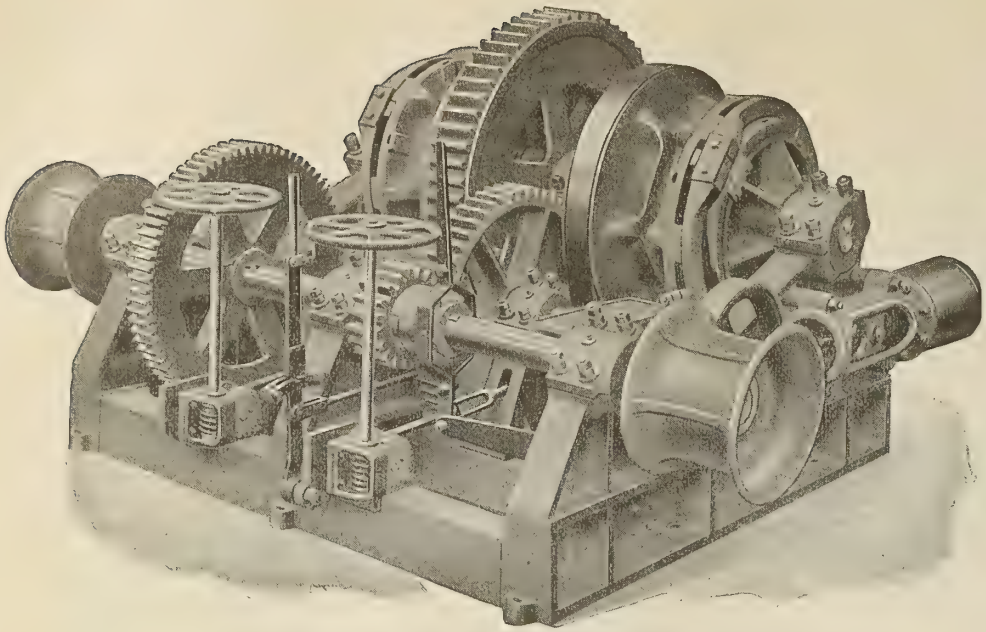
The United States Civil Service Commission is endeavoring to relieve the dearth of ship draftsmen by recommending to the heads of colleges and technical schools that senior students in engineering courses be given intensive training in naval architecture during the coming spring, with a view to making them available for employment as ship draftsmen in June. The Commission is also receiving applications from qualified architectural, mechanical and structural steel draftsmen, and is certifying them for employment in the Navy Department and in navy yards on ship work.

Not Required to Appear

Local boards of civil service examiners at the post offices in all of the larger cities are furnishing detailed information and application blanks. Applicants are not required to appear in an examination room, but are rated upon their education, training and experience.

Women Eligible as Ship Draftsmen in Navy Yards

Women can now help design ships for the United States Navy. They are eligible for employment as ship draftsmen in the navy yard service and mechanical, marine, engine and boiler draftsmen in the Navy Department. The increased needs of service caused by the war have thrown these positions open to them.



8¼-Inch by 10-Inch Mundy Windlass

How the J. S. Mundy Hoisting Engine Company is "Doing Its Bit"

In the construction of the ships for the Emergency Fleet, auxiliary equipment is as essential as the propelling machinery. Of particular importance is the machinery for steering by power, for hoisting anchor, for loading and unloading of cargo and for rapid handling of lines and hawsers. In this field the products of the J. S. Mundy Hoisting Engine Company, of Newark, N. J., have gained for themselves a foremost reputation among shipbuilders and owners. For over forty years this firm has been engaged in the manufacture of cargo hoists, winches and general hoisting and conveying machinery, being the originators of the cone friction drum now universally used on hoisting engines. In recent years it has also turned out many examples of up-to-date windlasses, steering engines and capstans.

Of particular interest at the present time are six vertical capstan windlasses recently built for use on United States submarines. These machines are constructed throughout of steel and bronze castings, a special manganese bronze being used, insuring great strength and avoiding all danger of corrosion. They will be driven through worm gearing by electric motors, and are arranged so that all operations are controlled from inside the hull. The chain wildcat and capstan barrel are on a vertical shaft passing through the hull, and may be unshipped when required, leaving the superstructure flush.

There has recently been completed six complete outfits for vessels of an American steamship company, each comprising a 7-inch by 10-inch steering engine of the drum type, a spur-geared windlass, with 8¼-inch by 10-inch engines, capable of handling 1¾-inch chain, and a hand steering gear of the right and left screw type. For handling cargo each ship will be supplied with six 8¼-inch by 10-inch winches.

This firm has recently supplied thirty-six winches to a shipyard on the great Lakes, twenty-two of the same type being placed on a large Atlantic freighter. They are also building for a steamship company of New York ten special winches, also fifty-five winches and twenty ash hoists with automatic stop for a yard on the Delaware. At present they have under construction for ships now building for Norwegian interests two windlasses for 2¼-inch chain, driven by 9-inch by 10-inch engines, also ten screw gear hand steerers.

Last year the Mundy Company furnished to the Navy Department two vertical capstan windlasses to be placed on vessels at Mare Island, Cal. These are driven through steel worms and bronze gears by engines hung on the underside of deck.

There is also being built for an Atlantic steamship company one of the largest size horizontal windlasses to handle 2¼-inch chain, and driven by 10-inch by 10-inch engines. For the same vessel there is also being supplied a 9-inch by 10-inch steering engine of the screw gear type, with hand steering attachment, and arranged for control either by telemotor or by hand, also nine 9-inch by 10-inch cargo winches.

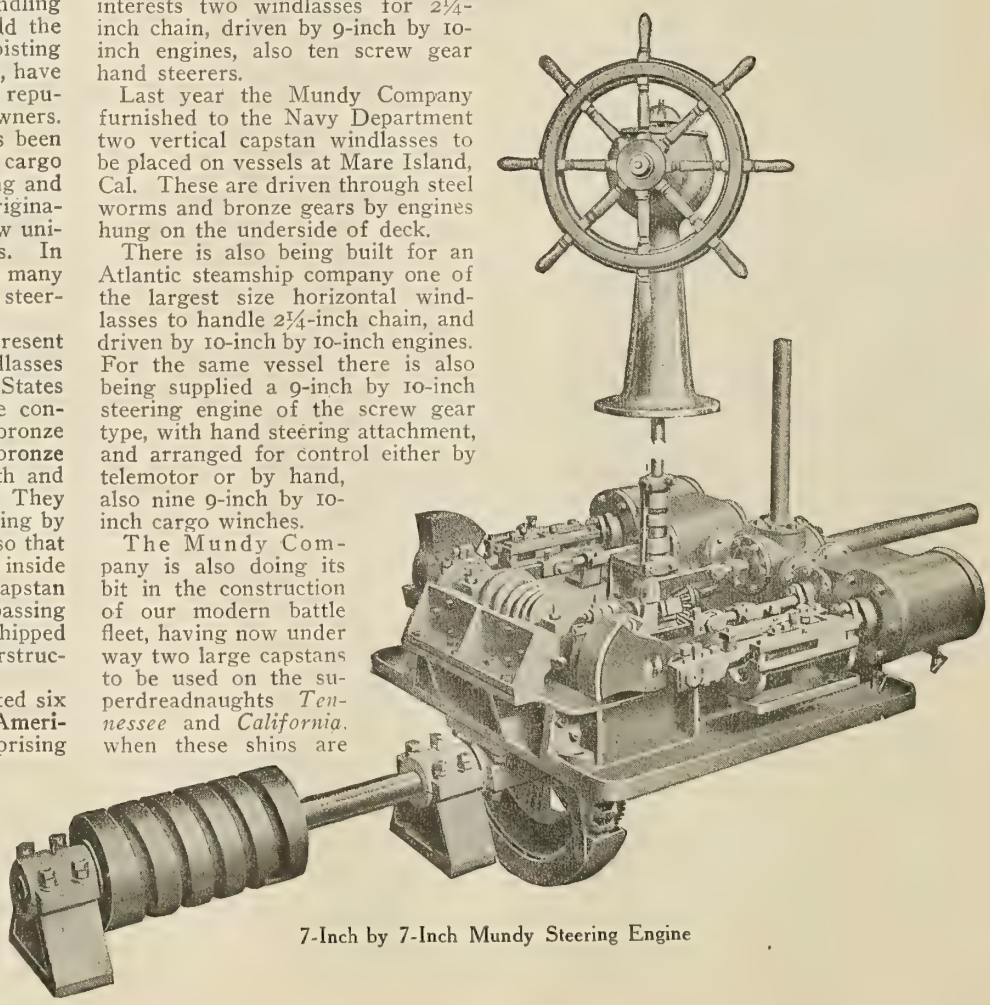
The Mundy Company is also doing its bit in the construction of our modern battle fleet, having now under way two large capstans to be used on the superdreadnaughts *Tennessee* and *California*, when these ships are completed. These machines are built throughout of steel castings of massive construction. The barrels will be located on the after-deck, and will be driven by 45-horsepower General Electric motors two decks below. The gearing is so arranged that two speeds may be obtained without altering the motor speed.

Another interesting installation is three 45-horsepower electric deck winches being supplied for the battleship *New Mexico*. These winches will be located in front of the forward turret and will have all gearing totally enclosed. The Mundy Company are also supplying the fire-room hoists for the same ship.

For export trade there is now building a 25-horsepower electric windlass and three electric winches, these being to the order of interests in the Dutch East Indies.

The Department of Commerce has recently placed an order for a gasoline (petrol) hoist fitted with a 12-horsepower Fairbanks engine for use in the United States Lighthouse Service.

The Mundy Company are fortunate at this time in having recently moved into their new and modern plant located on the Pennsylvania Railroad, and with their up-to-date equipment and years of experience, may be expected to add to their enviable reputation in the line of hoisting and marine machinery.



7-Inch by 7-Inch Mundy Steering Engine

Bush Piers Requisitioned by the War Department

The War Department, through the Acting Quartermaster-General, has requisitioned the Bush Terminal piers and warehouses in New York City. Of the piers and warehouses available on the Atlantic seaboard the Bush piers are regarded as the best for the purposes of the War Department.

American Ships and Cargoes Insured for More Than a Billion Dollars by the Government

Secretary McAdoo announces that the Bureau of War Risk Insurance, since its creation on September 2, 1914, to December 31, 1917, had issued insurance on the hulls and cargoes of American vessels of more than $1,000,000,000.

The total number of policies written was 13,844. The total premiums received by the Government have exceeded the total losses by $12,888,420.86.

Free Classes in Navigation Established in New York City

Two free classes in navigation for the training of qualified seamen for officers in the new American merchant marine will be conducted in New York throughout the winter by the United States Shipping Board Recruiting Service.

There will be seventy-five students to begin with in each class. The first class was opened December 1, at the Seamen's Church Institute, 25 South street, under the direction of Capt. Robert Huntington. The second class was opened December 15, under the direction of Capt. Fritz E. Uttmark, at 8 State street.

American citizens, 19 to 55 years old, having good vision and hearing and a working knowledge of arithmetic, will be accepted for either class on evidence of two years' experience at sea. The school term for each class will be from four to six weeks, according to the student, who, on graduation, will go before the local inspectors of steam vessels for his examination for a license.

Army Transport Meade Becomes Training Ship for Merchant Marine Apprentices

Announcement was made on January 23, at national headquarters of the United States Shipping Board Recruiting Service at the Boston Custom House, that the army transport *Meade*, formerly the Atlantic liner *City of Berlin*, has been assigned by the Shipping Board to the recruiting service for use as a training ship for apprentices in the American merchant marine. Headquarters for the training service are at Boston, where two training ships are already stationed, the *Calvin Austin* and the *Gov. Dingley*.

The *City of Berlin* was built at Greenock in 1874, and was famous as an Atlantic liner for nearly a generation thereafter. She held the transatlantic records, east and west, between Queenstown and New York, in 1875, her eastbound record being seven days, 15 hours and 48 minutes.

Taken by the United States Government in 1898, and renamed the *Meade*, she was used as a troopship in the Spanish war, and thereafter was more or less steadily employed as a transport until about seven years ago. Although laid up for the last seven years, she ship is reported to be in excellent condition. Her hull is sound and tight, and the repairs the vessel needs are chiefly to her upper works. Probably a month will be required in making these repairs, after which the ship may be used for receiving apprentices at Newport News before being transferred to the training station at Boston.

Seattle Establishing Shipbuilding Records

During the last two months of 1917 the combined shipbuilding plants in Seattle launched ten steel vessels with a total tonnage of 89,800, and two wooden vessels with a total tonnage of 5,000, or a total tonnage of 94,800 tons for the two months.

The largest vessel ever built on the Pacific Northwest coast is the steel steamship *Luckenbach*, recently launched by the Seattle Construction & Dry Dock Company.

Personal

STANLEY P. STEWART, mechanical engineer Stewart Boiler Works, Worcester, Mass., has been appointed assistant to the superintendent of the Machinery division of the American International Shipbuilding Corporation, Philadelphia, Pa.

JOSEPH T. MARTIN, superintendent of the Sparrows Point plant of the Bethlehem Steel Company, has resigned to become general manager of the Hog Island shipyard, Philadelphia, Pa.

FREDERICK W. WOOD has retired as general manager of the Sparrows Point (Maryland) plant of the Bethlehem Steel Company. Mr. Wood has been continuously engaged in the manufacture of steel and of shipbuilding for forty years, and has been chief executive of the great Sparrows Point plant since it was started in 1887. Mr. Wood will still be connected with the Bethlehem Steel Company in an advisory capacity, but will be succeeded by W. F. Roberts, of Bethlehem, as general manager of the corporation.

PETER DOIG, formerly with the firms of Brown, Clydebank; Beardmore's, Dalmuir; Shanghai Dock & Engineering Company, Shanghai, China, and Fore River Shipbuilding Corporation, Quincy, Mass., has been appointed general secretary of the Association of Engineering and Shipbuilding Draftsmen. The headquarters of this organization at present are in Glasgow, but will shortly be transferred to London.

D. M. CALLIS, formerly chief hull draftsman of the Seattle Construction & Dry Dock Company, Seattle, Wash., is now technical adviser for the United States Shipping Board, Northwest District, stationed at Seattle.

J. K. INGHAM has been appointed chief hull draftsman of the Seattle Construction & Dry Dock Company, Seattle, Wash., vice D. C. Callis, resigned.

P. S. STONE, formerly inspector for the Navy Department, Bureau of Construction and Repair, stationed at the Seattle Construction & Dry Dock Company, Seattle, Wash., has been appointed naval architect of the Patterson-McDonald Shipbuilding Company, of Seattle.

LLOYD J. WENTWORTH, president of the Portland Lumber Company, has been appointed head of the newly created Oregon district of the United States Shipping Board Emergency Fleet Corporation.

STANTON H. KING, of Boston, founder and head of the Sailors' Haven at Charlestown, Mass., has been appointed official chantie man for the American merchant marine.

C. P. COLEMAN was elected president of the Worthington Pump & Machinery Corporation, New York, on December 31.

FRANK J. FOLEY, manager of the mining section of the Industrial Department of the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., has accepted a position as manager of the Mining and Traction Department of the Edison Storage Battery Company, Orange, N. J.

GUY E. TRIPP, of New York, chairman of the Westinghouse Electric & Manufacturing Company, has been appointed by the War Department as chief of the production division of the Ordnance Department, entrusted with the task of supervising and stimulating the production of all ordnance supplies. The appointment of Mr. Tripp is one of the important steps in the reorganization of the Ordnance Bureau announced recently by its chief, General Crozier. The board of directors of the Westinghouse Company has given Mr. Tripp a leave of absence for the duration of the war.

H. A. HORNOR, electrical engineer of the New York Shipbuilding Corporation, Camden, N. J., has tendered his resignation, to take effect on February 1. Mr. Hornor has been connected with the New York Shipbuilding Corporation for seventeen years. He is chairman of the marine committee of the American Institute of Electrical Engineers, and a frequent contributor to the engineering press on subjects dealing with practical engineering features connected with the applications of electricity to the building and navigating of ships.

REAR ADMIRAL R. S. GRIFFIN, U. S. N., chief of the Bureau of Steam Engineering, has been reappointed as engineer-in-chief of the navy for another term of four years.

CAPT. C. W. DYSON, U. S. N., of the Bureau of Steam Engineering of the Navy Department, has been promoted to the rank of rear admiral.

JOHN F. COLEMAN, consulting engineer, New Orleans, La., has become chief engineer for the shipyards being constructed by the Tennessee Coal & Iron Company at Mobile, Ala.

W. B. FORTUNE, famed for his work in connection with the Quebec Bridge, has been retained in connection with ship construction at the Hog Island yard of the American International Corporation, Philadelphia, Pa.

Obituary

THOMAS G. MITCHELL, Lloyd's surveyor in British Columbia, died recently at his home in Vancouver, B. C.

EDWARD EVERETT ROBERTS, inventor of the Roberts marine watertube boiler and founder of the Roberts Boiler Company, Redbank, N. J., died recently at his home in Brooklyn, N. Y., at the age of 76. During the Civil War Mr. Roberts served for three years as engineer officer with Admiral Farragut's fleet, and for the last year of the war with Admiral Porter in the South Atlantic squadron, acting as chief engineer of the flagship *Colorado*, with the rank of captain.

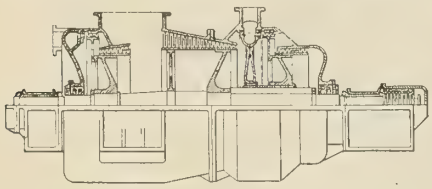
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,235,936. STEAM TURBINE. JAMES C. SHAW, OF PHILADELPHIA, PA., ASSIGNOR TO THE WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING COMPANY, A CORPORATION OF PENNSYLVANIA.

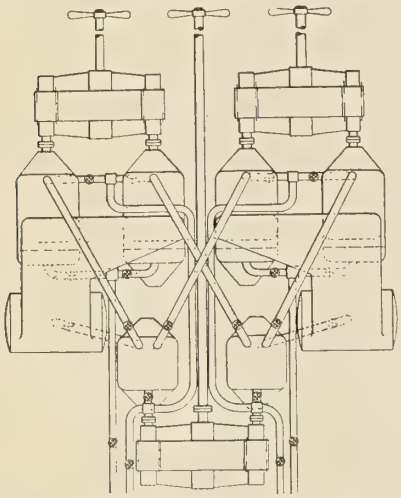
Claim 1.—In a marine steam turbine comprising a shaft carrying a propeller and opposed pressure staged drums having a resultant opposite to the propeller thrust, a single diaphragm between said drums and a compound velocity stage carried by one of said drums adjacent to said diaphragm for effecting a drop in the effective pressure before it



is applied to the drum head and initial drum stage, a live steam inlet close to said diaphragm at one side thereof and a steam conduit from the same side of said diaphragm beyond the drum on that side to the diaphragm at a point close thereto. Nineteen claims.

1,235,937. MARINE TURBINE PROPULSION. JAMES C. SHAW, of PHILADELPHIA, PA., ASSIGNOR TO THE WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING COMPANY, A CORPORATION OF PENNSYLVANIA.

Claim 1.—In a marine turbine installation, a high pressure turbine comprising two intergeared high pressure units, a low pressure



turbine comprising two intergeared units respectively in series therewith, and propelling means driven by said high and low pressure turbines. Thirty-four claims.

1,222,867. VESSEL BULKHEAD. ARCHIBALD HOGG, OF WALKER, NEWCASTLE-UPON-TYNE, ENGLAND.

Claim 1.—A bulkhead construction for ships comprising a transverse bulkhead formed of flat and curved plates disposed so that the curves of adjacent plates are reversed, the flat plates lying at the edges of the bulkhead parallel with the crests and valleys of the curved plates, the arc of each plate curve being limited in extent to not more than one-third of a circle and the width distance between adjacent curve crests exceeding four times the depth distance from crest to reversed crest, flanged joints between said flat plates and curved plates, and a continuous four-sided boundary frame comprising at least one angle bar, two sides of said frame being formed with broad shallow undulations which enter the undulations of the curved plates of the bulkhead, said frame being attached on all four sides both to the bulkhead and to the hull of the ship, all as set forth in the specification. Six claims.

1,223,319. FLYING-BOAT HULL. GLENN H. CURTISS, OF BUFFALO, N. Y., ASSIGNOR TO CURTISS AEROPLANE AND MOTOR CORPORATION, A CORPORATION OF NEW YORK.

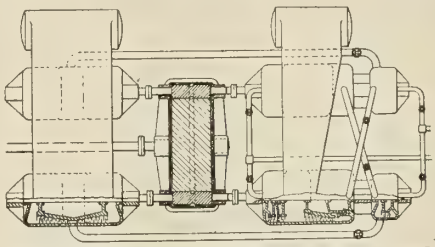
Claim 1.—In a hull for flying boats, a hydroplaning bottom, and fin excrescences formed by extending the bottom planking laterally beyond the chines of the boat body proper. Twenty-two claims.

1,236,539. MEANS FOR LOCATING AND SECURING SUNKEN VESSELS TO HOISTING APPARATUS. THOMAS J. CAHILL, OF SAN FRANCISCO, CAL.

Claim 1.—In combination, a pair of flexible members, one presenting a link through which the other flexible member passes, a crossbar carried by said other flexible member for engaging the link, a hook connected to said other flexible member, floats associated with said hook for maintaining the hook in an upright position in water, a buoy, a flexible member connecting the buoy to the hook, a chain link carried by said flexible member, and a severable member connecting said links to the buoy. Three claims.

1,235,928. COMPOUND GEARED TURBINE. JAMES C. SHAW, OF PHILADELPHIA, PA., ASSIGNOR TO THE WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING COMPANY, A CORPORATION OF PENNSYLVANIA.

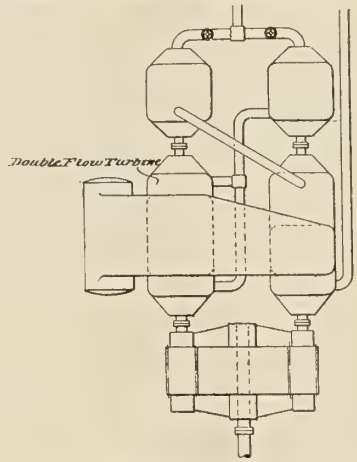
Claim 1.—In a marine turbine installation, a plurality of high pressure units adapted to operate in parallel, a plurality of low pressure



units supplied by each high pressure unit, said high and low pressure units being geared to a propeller shaft, and means for variably cutting out said low pressure units to obtain powers between one-half and seven-eighths. Twenty-four claims.

1,235,939. COMPOUND GEARED TURBINE. JAMES C. SHAW, OF PHILADELPHIA, PA., ASSIGNOR TO THE WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING COMPANY, A CORPORATION OF PENNSYLVANIA.

Claim 4.—In a marine turbine installation, a plurality of shafts each having a high pressure unit and a low pressure unit, a propeller shaft geared to both of said shafts, means connecting the low pressure unit on each shaft in series with the high pressure



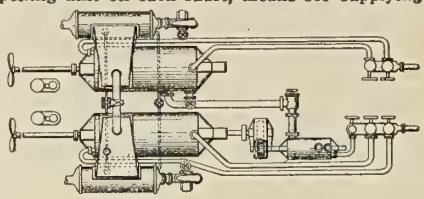
unit on the other shaft, said respective high and low pressure turbines passing predetermined portions of the total fluid pressure at equal speeds of revolution, and means for obtaining reduced power by cutting out one of said high pressure units and its connected low pressure unit. Twenty-three claims.

1,235,991. MARINE PROPULSION. JOHN F. METTEN, OF PHILADELPHIA, PA., ASSIGNOR TO THE WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING COMPANY, A CORPORATION OF PENNSYLVANIA.

Claim 1.—In a marine steam turbine installation, separated forward and after engine rooms, the forward engine room containing main geared units, wing shafts driven respectively by said units, the after engine room doing away with the strains due to the recontaining main geared turbines, center shafts driven by said last mentioned turbines respectively, means for disconnecting the forward main units at the after engine room, high pressure turbines, and means for connecting said wing shafts to be driven by said high pressure turbines. Seventeen claims.

1,235,990. SYSTEM OF MARINE STEAM TURBINES. JOHN F. METTEN, OF PHILADELPHIA, PA., ASSIGNOR TO THE WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING COMPANY, A CORPORATION OF PENNSYLVANIA.

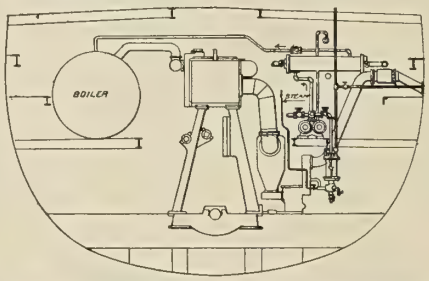
Claim 1.—In a marine propulsion arrangement, a plurality of shafts, a full power propelling unit on each shaft, means for supplying



power to said units for full power, a high speed cruising unit geared to one of said shafts, and means for passing the exhaust from said high speed cruising unit to the full power unit on the other shaft to produce approximately equal powers on said shafts for cruising speed. Eight claims.

1,238,187. FEED WATER HEATING APPARATUS. ERNST PELTON AND STANLEY D. HOPTON, OF GENEVA, OHIO.

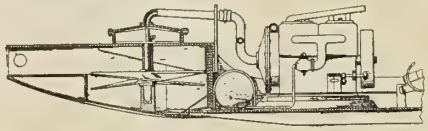
Claim 1.—In an installation, a steam engine having an exhaust pipe, a condenser open to said exhaust pipe, a stand pipe constituting a discharge connection for the condenser, feed



water connections open to said discharge connection and a feed water heater therein below the normal head of water in the stand pipe, said heater having a steam jet arranged to discharge into the water and provided with a separate vapor and water outlet connections. Three claims.

1,238,408. PNEUMATICALLY PROPELLED HYDROPLANE. RAY E. KELLOGG, OF LOS ANGELES, CAL.

Claim 3.—In a hydroplane, a substantially rectangular shaped hull having a bottom wall upturned at its forward end to provide a bow and having its side walls projecting below the bottom wall rearwardly of such upturned end and formed with a transverse opening adjacent the juncture of the upturned end with the remaining portion of the bottom wall, and means for forcing air through the transverse opening for propelling the hull, said means including a cylindrical well formed in the hull adjacent the bow, a hood covering the well and extending flush with the bow throughout the entire width of the hull and open at its forward end throughout the entire width of the hull, and a fan propeller mounted in the well to draw air through the hood and discharge it through the opening in the bottom of the hull. Fourteen claims.



1,237,393. APPARATUS FOR CONTROLLING THE RUDDERS OF SUBMARINES AND OTHER VESSELS. EUGENE SCHNEIDER, OF LE CREUZOT, FRANCE.

Claim 1.—The dependence between the power steering control and the axiometer pointer, which is one of the essential characteristic features of this invention, renders the power steering apparatus completely reversible and allows the rudder to become a motor when struck, for instance, by a heavy sea.